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NASA Procedures and Guidelines

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NASA Safety Manual

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Appendices

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PREFACE

P.1 PURPOSE

This NASA Safety Manual is the central Agency document containing procedures and guidelines that define the NASA Safety Program. This document serves as a general framework to structure the more specific and detailed requirements for Headquarters, Program, and Center Directors. This document does not stand alone but rather must be used in conjunction with the references listed in paragraph P.4 below.

This is primarily a safety document and is not meant to provide direction to occupational health personnel or to provide guidance for occupational health activities. Some health references are included to assist Center safety personnel in interactions with the occupational health personnel. Joint occupational safety and health requirements that implement 29 CFR 1960 are specified in NPG 8715.1, "NASA Safety and Health Procedures and Guidelines-Occupational Safety and Health Programs."

To address special processes and/or discipline-unique processes, the Safety and Risk Management Division publishes standards that provide specific instructions that are beyond the scope and detail of this document. A listing of applicable NASA standards can be found in paragraph P.4.

P.2 APPLICABILITY

The procedures and guidelines in this document apply: (1) to all NASA organizations, elements, entities, or individuals; (2) to visitors on NASA property; (3) to all NASA equipment, property, systems, and facilities; (4) during all phases of the life cycle of systems or facilities; and (5) as specified in contract requirements.

This document is not a direct instruction to NASA contractors, but provides guidance to the responsible NASA contracting officer. It is applicable to contractors as appropriate through contract clauses in conformance with the NASA Federal Acquisition Regulation (FAR) Supplement. Non-NASA, non-contractor personnel will follow the provisions of this document when on NASA property. This document shall not supersede more stringent requirements imposed by individual NASA organizations and other Federal, State, or local government agencies.

P.3 AUTHORITY

42 U.S.C. 2473(c) (1), Section 203(c)(1) of the National Aeronautics and Space Act of 1958, as amended.

5 U.S.C. Section 7902, 29 U.S.C. Sections 651 et seq., and 49 Appendix Section 1421, the Occupational Safety and Health Act of 1970 (Public Law (PL) 91-596), as amended.

Executive Order (E.O.) 12196 of February 26, 1980, Occupational Safety and Health Programs for Federal Employees.

29 CFR Part 1910, Occupational Safety and Health Standards.

29 CFR Part 1960, Basic Program Elements for Federal Employees, Occupational Safety and Health Programs and Related Matters.

NHB 1101.3, The NASA Organization, (Chapter 4, 416, Office of Safety and Mission Assurance, Code Q).

P.4 REFERENCES.

5 U.S.C. Section 7903, Protective Clothing and Equipment.

40 U. S.C. Section 619, Compliance with Nationally Recognized Codes (Section 6 (a) of P.L. 100-678, November 17, 1988), as amended.

42 U.S.C. 11001 et seq., Emergency Planning and Community Right-To-Know Act.

E.O. 113043 of April 16, 1997, Increasing Seat Belt Use in the United States.

5 CFR Parts 532, 550, Prevailing Rate Systems and Pay Administration (General).

14 CFR Part 1214.5, Mission Critical Space Systems Personnel Reliability Program.

21 CFR Part 1040, Performance Standards for Light Emitting Products.

49 CFR Parts 177, 571, Carriage by Public Highway; Federal Motor Vehicle Safety Standards.

EM 385-1-1, U.S. Army Corps of Engineers, Safety and Health Requirements.

NHS/IH-1845.3, Hazard Communication.

NHS/IH-1845.5, Occupational Exposure to Hazardous Chemicals in Laboratories.

NPC 1152.66C, NASA Space Flight Safety Panel.

NPD 1800.1, NASA Occupational Health Program Policy.

NPD 3810.1, Processing Claims Under the Federal Employees Compensation Act.

NPD 6000.1, Transportation Management.

NPD 7100.8B, Protection of Human Research Subjects.

NPD 8070.6, Technical Standards.

NPD 8621.1, NASA Mishap Reporting and Investigating Policy.

NPD 8700.1, NASA Policy for Safety and Mission Success.

NPD 8710.1, Emergency Preparedness Program.

NPD 8710.2, NASA Safety and Health Program Policy.

NPD 8710.3, NASA Policy for Limiting Orbital Debris Generation.

NPD 8710.5, NASA Policy for Pressure Vessels and Pressurized Systems.

NPG 1441.1, NASA Records Retention Schedules.

NPG 1700.6A, NASA Procedures and Guidelines for Pressure Vessels and Pressurized Systems.

NPG 2810.1, Security of Information Technology.

NPG 3451.1, The NASA Awards and Recognition Program.

NPG 4100.1, NASA Materials Inventory Management Manual.

NPG 4200.1, NASA Equipment Management Manual.

NPG 5100.4, Federal Acquisition Regulation Supplement (NASA/FAR Supplement).

NPG 7120.5, Program and Project Management Process and Requirements.

NPG 7900.3 (V1), Aircraft Operations Management Manual.

NPG 7900.3 (V2), Mission Management Aircraft Operations Manual.

NPG 8060.1, Flammability, Odor, Off-gassing and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion.

NPG 8621.x, NASA Procedures and Guidelines for Mishap Reporting, Investigation, and Recordkeeping.

NPG 8715.1, NASA Safety and Health Handbook - Occupational Safety and Health Programs.

NPG 8715.x, NASA Emergency Preparedness Program Plan.

NPG 8820.3, Pollution Prevention.

NPG 8831.2, Facilities Maintenance and Energy Management Handbook.

NPG 8840.x, NASA Procedures and Guidelines for Implementating the National Environmental Policy Act, and Executive Order 12114.

NASA-STD-8719.7, Facility System Safety Guidebook.

NASA-STD-8719.8, NASA ELV Payload Safety Review Process Standard.

NASA-STD-8719.9 (will replace NSS 1740.9), NASA Safety Standard for Lifting Devices and Equipment.

NASA-STD-8719.10 (will replace NSS 1740.10), NASA Safety Standard for Underwater Facilities and Non-Open Water Operations.

NASA-STD-8719.11 (will replace NSS-1740.11), NASA Safety Standard for Fire Protection.

NASA-STD-8719.12 (will replace NSS 1740.12), NASA Safety Standard for Explosives, Pyrotechnics, and Propellants.

NASA-STD-8719.13 (will replace NSS 1740.13), NASA Software Safety Manual.

NASA-STD-8719.14 (will replace NSS 1740.14), NASA Safety Standard for Guidelines and Assessment Procedures for Limiting Orbital Debris.

NASA-STD-8719.15 (will replace NSS 1740 15), NASA Safety Standard for Oxygen and Oxygen Systems.

NASA-STD-8719.16 (will replace NSS 1740.16), NASA Safety Standard for Hydrogen and Hydrogen Systems.

National Aeronautics and Space Administration Charter of the NASA Aerospace Safety Advisory Panel, April 29, 1999.

JSC NSTSPM Directive No. 110, Space Shuttle Program (SSP) System Safety Review Panel (SSRP) Charter.

NSTS 1700.7B, Safety Policy and Requirements for Payloads Using the Space Transportation System and Addendum.

JSC Policy Charter, JPC 1152.4K, Space Shuttle Payload Safety Review Panel (PSRP).

ANSI/ASQC Q90001-1994.

Presidential Directive/National Security Council Memorandum Number 25 (PD/NSC-25), Scientific or Technological Experiments with Possible Large-scale Adverse Environmental Effects and Launch of

Nuclear Systems into Space.

P.5 CANCELLATION

This document cancels NHB 1700.1(V1-B), dated June 1993. The mishap provisions from Chapter 10, Mishap Reporting, Recordkeeping, and Investigating, will be replaced by NPG 8621.x, NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping.

/s/Frederick D. Gregory
Associate Administrator for
Safety and Mission Assurance

CHAPTER 1. Basic Safety Management

1.1 General

1.1.1 This document provides the procedures and guidelines that define the NASA Safety Program. Safety program responsibility starts at the top with senior management's role of developing policies and providing strategies and resources and is executed by the immediate task supervisor and line organization. All employees are responsible for their own safety, as well as that of others whom their actions may affect. Employees are empowered to call for the halt of any process or operation they believe is unsafe and request analysis by a qualified individual. If the activity is unsafe, the qualified individual will determine the corrective actions needed. Employees are also to report any systems designs, operations, processes, or software they feel are unsafe or do not meet safety requirements.

1.1.2 In general, the success or failure of an organization's safety efforts can be measured by the number of incidents involving injury or death to personnel, lost productivity (lost or restricted workdays), environmental damage, or loss of, or damage to, property. These failures can also be measured by increased development time, longer cycle time, operational delays, reduced quality, increased costs, loss of program capability, and loss of technical reputation or stature. Like many successful corporations, NASA has learned that aggressively preventing mishaps is good management and good business practice.

1.1.3 NASA undertakes many activities involving a high potential of risk. Management of this risk (which involves identifying and eliminating, minimizing, controlling, or accepting the risk) is one of NASA's most challenging activities and is an integral part of NASA's safety efforts. The focus of risk management and loss prevention priorities and attention are:

1.1.3.1 Public.

1.1.3.2 Astronauts and pilots.

1.1.3.3 NASA workforce.

1.1.3.4 High-value equipment and property.

1.2 Fundamental Policy

1.2.1 The policy for the NASA Safety Program is provided in NPD 8710.2, "NASA Safety and Health Program Policy." For specific health program requirements, see NPD 1800.1, "NASA Occupational Health Program."

1.2.2 NASA's goal of a world-class safety program is based on the following four essential components:

1.2.2.1 Management commitment and employee involvement.

1.2.2.2 System and worksite hazard analysis.

1.2.2.3 Hazard prevention and control.

1.2.2.4 Safety and health training.

1.3 Objectives and Principles

The objectives of NASA's Safety Program are to affect positively the overall success rate of missions and operations and to prevent injury to personnel, loss of or damage to property, loss of technical stature, or environmental harm. Requisite program principles include the following:

1.3.1 An aggressive and independent safety function for NASA to ensure that its programs/projects are accomplished with proper safety planning.

1.3.2 Planning, direction, development of requirements, policies, methodology, procedures, implementation, and evaluation of the safety program to ensure its goals are achieved effectively and efficiently.

1.3.3 Compliance with the safety standards issued by the Occupational Safety and Health Administration (OSHA) pursuant to Section 6 of Public Law (PL) 91-596 (the Occupational Safety and Health Act of 1970 as amended), 29 U.S.C. Section 655. If no OSHA standards apply, NASA will develop its own supplementary or alternate NASA standards for safety and mission assurance to support its unique operations, materials, facilities, equipment, procedures, and practices. See NPD 8070.6, "Technical Standards," and NPG 8715.1, "NASA Safety and Health Handbook - Occupational Safety and Health Programs," for further information on the policy for all NASA Technical Standards.

1.3.4 Up-to-date configuration control on equipment and systems.

1.3.5 Technical reviews by the developing organization of the safety aspects of all development efforts and operations to ensure that they are being conducted in accordance with sound safety engineering principles.

1.3.6 Safety assessments of all systems prior to changes so as to preclude an increase in risk to personnel or equipment. Assessments of both qualitative and quantitative safety risks to people or property along with recommendations to either reduce the risks or accept them. Final risk acceptance is a management responsibility. However, employees have the right to be informed of the risk acceptance process if it affects their personal safety or health.

1.3.7 Investigation of all hazardous conditions, close calls, environmental incidents, and mishaps, without retribution to the employees, and the prompt publication of lessons-learned as part of accident prevention and a continuous improvement effort. Procedures for mishap and close call reporting are found in NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigation, and Recordkeeping."

1.3.8 Safety oversight/insight and periodic inspection to ensure compliance with NASA safety policies and assess the effectiveness of NASA safety activities as required by NASA policy, Federal regulations, State regulations where applicable, and national consensus standards.

1.3.9 Safety research and development for new or unique safety functions and technologies to establish NASA as a national focal point for safety.

1.3.10 Commitment to the quality management principles of ISO 9000 and third party registration.

1.4 Authority and Responsibility

The NASA Associate Administrator for Life and Microgravity Sciences and Applications is the NASA Designated Agency Safety and Health Official (DASHO), pursuant to Executive Order 12196, Section 1-102. The DASHO coordinates the NASA Occupational Safety and Health Programs (reference NPD 8710.2, "NASA Safety and Health Program Policy"). The authority and responsibility for safety policy and oversight of its implementation are vested in the Safety and Risk Management Division within the Office of Safety and Mission Assurance (OSMA). Responsibility for safety at NASA facilities rests with the Center Directors.

1.5 Program Elements

Center Directors and the Associate Administrator for Headquarters Operations shall ensure that --

1.5.1 The safety organization is placed at a high enough level and the program implementation authority is vested in a person sufficiently senior to manage the effort so the safety review function can be conducted independently. (High enough level is interpreted to mean that the Safety Assurance Functional Director can interface directly with the Center Director when problems arise.) Center Directors and the Associate Administrator for Headquarters Operations must also ensure that adequate resources are made available to support the safety efforts and that the safety responsibilities of each organizational element are properly emphasized and accomplished. Proper safety organizational alignment will support the importance of safety at all organizational levels.

1.5.1.1 Senior managers incorporate safety considerations into the planning and execution of programs, projects, and operations in their management function. The officials to whom they report will evaluate and document this in their performance evaluations.

1.5.1.2 Line managers are accountable for the safety of their workers. Their supervisors will incorporate measurable performance criteria in line manager's performance plans and evaluate and document results in their performance evaluations.

1.5.1.3 Employees must be trained to work safely and to follow prescribed workplace rules to protect their own and their fellow workers' safety and health. Managers and supervisors will assure this is included as part of the formal performance evaluation process and will further encourage safe performance through safety incentive awards programs.

1.5.2 Centers establish executive safety and health committees or boards in accordance with NPG 8715.1, "NASA Safety and Health Handbook -- Occupational Safety and Health Programs." The board will provide executive oversight, strategic planning, and program implementation in support of the safety and health programs.

1.5.3 Policies, plans, procedures, and standards that define the parameters of the safety program are established, documented, maintained, communicated, and implemented to provide for the appropriate or adequate protection and prevention of loss and damage to personnel, property, material, equipment, and facilities of NASA, other agencies, and the public. The Annual Operating Agreements enacted and signed at each Center reflect the agreed support activity level of the Center safety organization to the program/projects and institutional operations at the Centers. (See NPD 8700.1, "NASA Policy for Safety and Mission Success.")

1.5.4 Appropriate safety and mission assurance risk-based acquisition management (R-BAM) requirements are included in procurement, design, development, fabrication, test, or operations of systems, equipment, and facilities and will serve as a basis for awarding any fee on contracts. Contractor operations and designs are evaluated for consistency and compliance with the safety provisions of the contract concerning good safety practices. These results are provided to the award fee boards and used to affect the fee determination, where applicable. NASA safety personnel are included as regular participants in the procurement process for the acquisition of hardware, software, services, materials, and equipment. (See Chapter 2.)

1.5.5 An effective systems safety and mission assurance program based on a continuous risk assessment process is established to include development of safety requirements early in the planning phase, review of the implementation of those requirements during the acquisition, development, and operational phases, and the use of a risk-based hazard assessment and tracking system to maintain status of the hazards during the process. (See Chapter 3.)

1.5.6 Qualified personnel and appropriate training are provided to support the safe performance of potentially hazardous or critical technical operations and to ensure a qualified safety workforce is available to support the safety assurance function. To meet the requirements of the Voluntary Protection Program (VPP), the safety organization (or its support contractors) must employ a certified safety professional. Special circumstances involving access to mission critical space systems and other critical equipment may dictate the need for the Personnel Reliability Program (14 CFR Part 1214.5, Mission Critical Space Systems Personnel Reliability Program). (See Chapter 4.)

1.5.7 An ad hoc interagency review and approval process is implemented for the use of radioactive materials in spacecraft and the Space Transportation System to avoid unacceptable radiation exposure for normal or abnormal conditions, including launch aborts with uncontrolled return to Earth. (See Chapter 5.)

1.5.8 All NASA operations are performed in accordance with existing safety standards and consensus standards, or special supplemental standards when there are no known applicable standards. For hazardous operations, special procedures are developed to provide for a safe work environment. (See Chapter 6.)

1.5.9 Aviation safety programs tailored to meet the specific operational needs of the NASA Centers are established and maintained to comply with national standards and NASA directives and guidance. (See Chapter 7.)

1.5.10 All facilities are designed, constructed, and operated in accordance with applicable/approved codes, standards, and procedures. (See Chapters 8 and 9.)

1.5.11 All accidents, incidents, mission or test failures, or other mishaps are promptly investigated for the dominant root cause. The emphasis will be on determining what happened without the threat of punitive actions. Continuous improvement is initiated through corrective actions and lessons learned, as specified in NPD 8621.1, "NASA Mishap Reporting and Investigating Policy," and NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping." Events resulting in significant release of pollutants to the environment are coordinated with the cognizant NASA environmental management organization for appropriate response and reporting to regulatory authorities, as specified in NPG 8820.3, "Pollution Prevention."

1.6 Public Safety

1.6.1 The first safety priority of NASA is to protect the public from any adverse effects of NASA operations. NASA Center Directors, program/project managers, and line supervisors will strive to eliminate the risk or the adverse effect of NASA operations on the public. Where NASA can not do this, NASA will provide protection by exclusion or other protective measures. If there is a likelihood that the public and surrounding communities could be affected by NASA operations, NASA safety and emergency planning officials will establish cooperative programs with the local communities. Local NASA safety and emergency planning officials will perform the following:

1.6.1.1 Ensure community awareness regarding the nature and extent of actual and potential hazards arising from the NASA operations and the measures to be taken to protect the community.

1.6.1.2 Jointly develop emergency response plans, including protective action guides, to address the effects posed by hazards from radiological contamination, explosive/propellant mishaps, and toxic chemical spills.

1.6.1.3 Participate in community safety activities and cooperate with local authorities to develop response plans to contend with natural disasters such as tornadoes, hurricanes, and floods.

1.6.1.4 Coordinate emergency planning, response, and notification activities required by Section 313 of the Emergency Planning and Community Right-To-Know Act (42 U.S.C. Section 11023) involving local jurisdictions with the appropriate NASA environmental management organization, following the procedures established in NPG 8820.3, "Pollution Prevention."

1.6.2 Occasionally, research personnel who are neither contractors or visitors are allowed access to NASA facilities to conduct individual research under grants or cooperative agreements. These research operations must not be allowed to interfere with or damage NASA facilities or operations. If their work involves exposure to hazardous operations, the Center safety office shall require them to follow all NASA precautions and to procure protective clothing and equipment at their own expense, if needed. Also, if these personnel will be operating or using potentially hazardous NASA equipment, they must receive training and be certified as a qualified operator in accordance with Chapter 4 of this document.

1.7 Risk Assessment

The primary purpose of risk assessment is to identify and evaluate risks to support decisionmaking regarding actions to ensure safety and mission success as well as to support decisionmaking in other areas, such as selection of contract type, development of fee incentives and surveillance plans, and information security. The decision (based on all relevant factors) to accept a hazard with its associated risk is a line management responsibility but will require coordination with the cognizant safety official. In all cases, when a decision is made to accept a hazard with its associated risk, that decision will be communicated to the next higher management level for review. The probability of a mishap coupled with the severity of the possible consequences should be a major consideration in that decision. This is discussed in detail in paragraph 3.5.

Risk assessment analysis should use the simplest methods that adequately characterize the probability and severity of undesired events. Qualitative methods that characterize hazards and failure modes should be used first. Quantitative methods should be used when qualitative methods do not provide an adequate understanding of failure causes, probability of undesired events, or the consequences of hazards or potential failures.

1.8 Control of Hazardous Conditions

Systems shall be designed to preclude the occurrence of a hazard or to negate or reduce the effect of a hazard that cannot be eliminated. (See Chapter 3 for hazard reduction priority.) The level of protection required is a function of the hazard severity and probability, and may be achieved by a combination of availability, reliability, maintainability (restorability), and redundancy. Protection levels must include consideration for the possibility of operator error.

1.8.1 Failure Tolerance. Safety critical operations that control or are applied to a condition, event, signal, process, or item of which proper recognition, control, performance, or tolerance are essential to safe system operation, use, or function, shall be designed such that the operation or function is assured. Design for failure tolerance is driven by system probability of failure requirements in conjunction with incorporation of the proper levels of redundancy. Where there is sufficient time between a failure and the manifestation of its effect, design for restoration to safe operation using spares, procedures, or maintenance may be used as an alternative means of achieving failure tolerance. Where there is not sufficient time for recovery, functional redundancy must be provided.

1.8.1.1 An assessment of the probability of failure to provide the function and the estimated time to restore the function shall be used to specify the safety attributes of the design or operation where loss of life, serious injury, or catastrophic system loss is at risk. The probability of failure shall be demonstrated to a lower confidence level of 95 percent in concert with a demonstrated mean time to restore (where appropriate) not greater than 50 percent of the estimated time to repair. The time-to-repair estimate shall include the combination of the active time to repair and the logistics or administrative downtime that affects the ease or rapidity of achieving full restoration of the failed function. In the event where adequate demonstration data cannot be obtained directly to meet the required confidence limits, alternate methods of assuring a satisfactory level of risk must be proposed by the supplier and approved by the customer.

1.8.1.2 Use of redundancy to achieve failure tolerance requires specification of acceptable reliability and sufficient redundancy to tolerate two failures or operator errors (either fail-operational or fail-safe) where loss of life or mission critical event could occur and tolerate one failure or operator error (fail-safe) where system loss/damage or personal injury could occur. Use of redundancy shall include a verifiable requirement that common cause failures (e.g., contamination, close proximity) do not invalidate the failure tolerance. All redundancy in safety critical functions shall be verified under operational conditions.

1.8.2 Inhibits. An operation that requires control of a condition, event, signal, process, or item of which proper recognition, performance, or tolerance is essential to safe system operation, use, or function, shall be designed such that an inadvertent or unauthorized event cannot occur. Flight critical safety operations shall require three inhibits where loss of life or mission-critical events could occur, and two inhibits where personal injury or system loss or damage could occur. All inhibits or procedures in safety critical operations shall be verified under operational conditions. This is not to be confused with the lockout/tagout program, which is a program to isolate facility system hazards.

1.8.3 Loss of functional protection shall require termination of the operation at the first stable configuration.

1.8.3.1 For systems intended to be operated by humans, rescue and escape can be valid means of life protection, and if used, shall include testing for validation, training, and demonstration.

1.8.3.2 At least a single level of protection is required to protect hardware. For high-value or high visibility systems, the program shall consider additional protection against loss. The associated decision (s) and rationale shall be documented by the program.

1.9 Safety Program Reviews

1.9.1 General.

In addition to normal management surveillance, competent and qualified safety personnel through safety staff assistance visits, inspections, and process verification evaluations shall formally assess the Center safety program annually. The Center's safety staff or an independent outside source may perform the formal assessments. These assessments shall perform the following:

1.9.1.1 Evaluate the effectiveness of safety program management.

1.9.1.2 Evaluate the implementation of Public Law 91-596, "The Occupational Safety and Health of 1970,"as amended; E.O. 12196, "Occupational Safety and Health Programs for Federal Employees," as amended; OSHA Regulations at 29 CFR Part 1910, "Occupational Safety and Health Standards," and other pertinent Federally mandated requirements.

1.9.1.3 Identify hazards and deficiencies in the safety program.

1.9.1.4 Evaluate the effectiveness of the abatement process.

1.9.1.5 Determine the adequacy of safety standards and procedures.

1.9.1.6 Observe compliance with safety practices.

1.9.1.7 Verify corrective actions from previous assessments.

1.9.2 Review Categories. Three types of qualitative assessments are described below.

1.9.2.1 Safety staff assistance visits are informal onsite evaluations by specialists and safety personnel who, after making spot checks and/or sampling and holding discussions with appropriate levels of management, provide assessments to the affected organization.

1.9.2.2 Safety inspections are in-depth technical reviews conducted at the working or facility level to assess the compliance with safety policies and standards that apply to the particular workplace. The safety inspection team will provide formal reports to the appropriate management level responsible for correcting the deficiencies.

1.9.2.3 Process verification examinations are documented Headquarters-level reviews performed in accordance with pre-approved subject area outlines to verify, by examination and evaluation of objective evidence, whether required safety and mission assurance program elements are in place and functioning. Although the process verification team provides a written report, specific written responses are not required. Corrective actions are documented through normal reporting processes and follow-up assessments.

1.10 Notice and Abatement of Unsafe or Unhealthful Conditions

The receipt of information concerning unsafe conditions, whether received through a report from an employee and verified, or as a result of a workplace inspection, will require the issuance of a Notice of Unsafe or Unhealthful Condition (NF 1390) and may require a NASA Safety and Health Hazard Abatement Form (NF 1584) or equivalent forms. These forms are available to NASA employees and contractors at ftp://ftp.hq.nasa.gov/forms/pdf/nf1390.pdf for NASA Form 1390 and ftp://ftp.hq.nasa.gov/forms/pdf/nf1584.pdf for NASA Form 1584. Imminent danger issues will be addressed in accordance with 29 CFR Section 1960.26, "Conduct of Inspections." (See NPG 8715.1, "NASA Safety and Health Handbook -- Occupational Safety and Health Programs," for more information.)

1.10.1 Inspection requirements vary according to the type of unsafe or unhealthful conditions that are reported.

1.10.1.1 An allegation of an imminent danger condition will require an inspection within 24 hours.

1.10.1.2 An allegation of a potentially serious condition requires an inspection within three working days.

1.10.1.3 Any allegation of other than imminent or serious safety or health conditions shall be inspected within 10 working days.

1.10.1.4 Further inspections may not be necessary if the hazardous condition(s) can be abated immediately through normal management action and prompt notification to employees and safety and health committees if the abatement is permanent.

1.10.2 Written reports/notices of safety violations shall be issued not later than 15 working days after completion of the inspection and confirmation by the inspection official. Written reports/notices for health violations shall be issued not later than 30 working days after completion of the inspection and confirmation by the inspection official.

1.10.2.1 A copy of the notice shall be sent to the supervisor in charge of the workplace, the representative of the employees, and the safety and health committee of the workplace, if any.

1.10.2.2 Upon receipt of any notice of an unsafe or unhealthful working condition, the supervisor in charge of the workplace shall post such notice (when required by the safety or health office) at or near each place where the condition exists or existed.

1.10.2.3 Each notice shall remain posted (when required) until the unsafe or unhealthful working condition has been abated or for three (3) working days, whichever is later.

1.10.3 An Abatement Plan (NF 1584 or equivalent) is required for hazards that cannot be abated within 30 days. A copy shall be provided to the safety and health committee and employee representatives as applicable. A copy must be provided to the Safety and Risk Management Division if Headquarters advocacy is required to secure funding. In all cases, operations will not proceed until alternative procedures are in place to provide temporary mitigation or reduction of the risk to acceptable levels.

1.10.4 As part of the annual OSHA report to the DASHO, Centers shall send the Safety and Risk Management Division a summary of all open Abatement Plans and open variances, and a listing of all Abatement Plans and variances closed during the previous reporting period. See paragraph 1.15.2.6 for more information.

1.11 Advisory Panels, Committees, and Boards

1.11.1 General.

It is NASA's intent that maximum use be made of the Nation's most competent safety resources. In keeping with this philosophy, NASA may enlist consultants, interagency and interdisciplinary panels, and ad hoc committees, consisting of representatives from industry (management and union), universities, and government (management and union), to review and advise on the needs of the NASA Safety Program.

1.11.2 Aerospace Safety Advisory Panel (ASAP).

This panel was established by Public Law 90-67 to serve as a senior advisory body to the NASA Administrator. The panel reviews safety studies and operations plans referred to it, prepares reports, and advises the Administrator with respect to the hazards to proposed or existing facilities and operations. See the National Aeronautics and Space Administration Charter of the NASA Aerospace Safety Advisory Panel, April 29, 1999, for further details.

1.11.3 Operations and Engineering Board (OEB).

This internal NASA board reports to the Associate Administrator for Safety and Mission Assurance (AA/OSMA). The board supports the AA/OSMA on special assignments related to facilities operations and engineering activities. The OEB evaluates processes and systems for assuring the continuing operational integrity of NASA test facilities, operations and engineering technical support systems, and problems and issues at Centers, and provides recommendations to management in these areas. The OEB also studies technical support system problem areas and develops alternate solutions or methods for arriving at a solution. See NPC 8701.1, "Operations and Engineering Board Charter," for further details.

1.11.4 International Space Station Independent Assessment Panel (ISSIAP).

The ISSIAP was chartered in the International Space Station Management Agreement dated July 28, 1994. The ISSIAP provides an independent assessment function for AA/OSMA that encompasses the products and activities of all program participants throughout the entire life cycle of the International Space Station (ISS) program. The ISSIAP, to the maximum extent practicable, provides timely identification of program deficiencies and unacceptable risks, and makes recommendations concerning risk acceptability. The activities of the ISSIAP are complementary to the in-line safety, reliability, and quality assurance activities of the ISS program.

1.11.5 System Safety and Risk Management Assistance Committee (SSARMAC).

This committee, established by letter from the Director, Safety and Risk Management Division, in August 1997, is chartered to (1) enhance the development, review, and reengineering of system safety and risk management policies; (2) facilitate the identification and prioritization of system safety research and technology activities; (3) foster the exchange of system safety and risk management experiences and successes within NASA; and (4) serve as a forum for discussion of issues. One member or members (if separate system safety and risk management representatives are needed) will be appointed from each Center and the Jet Propulsion Laboratory.

1.11.6 The System Safety Review Panel (SSRP) is a mechanism for enhancing the Space Shuttle program (SSP) system safety management and engineering through informational interchanges, development of concepts to improve the SSP safety program, review of safety documentation, review of SSP integration and cargo integration, review of SSP element-level hazard identification and resolution activities, and recommendations to Level 2 management for hazard report disposition. See JSC NSTSPM Directive No. 110, "Space Shuttle Program (SSP) System Safety Review Panel (SSRP) Charter," for further details.

1.11.7 HEDS Assurance Board (HAB).

This board was created pursuant to the "Safety and Mission Assurance for the Human Exploration and Development of Space (HEDS) Enterprise" plan, dated April 3, 1996. Its purpose is to provide senior NASA management with timely, objective, non-advocacy assessments of program health and status and the relative safety posture of the HEDS Enterprise. The HAB assesses the work processes of the SMA community, reviews HEDS programs to ensure that proper attention is being paid to risk, and reviews the overall effectiveness of the hardware, software, and operational aspects of HEDS programs to assure safety and mission integrity. The HAB places special emphasis on the transition to the Space Flight Operations Contract and from NASA oversight to insight. The Board is chaired by the AA/OSMA, and includes the SMA directors from Johnson Space Center, Kennedy Space Center, and Marshall Space Flight Center; the Chair of the Space Flight Safety Panel; the HEDS Independent Assurance Director; and the SMA managers for the Space Shuttle program and the International Space Station program.

1.11.8 Space Flight Safety Panel.

This panel was established to promote flight safety in NASA space flight programs involving flight crews and to advise appropriate Associate Administrators on all aspects of the crewed space program that affect flight safety. See NPC 1152.66C, "NASA Space Flight Safety Panel," for further details.

1.11.9 Pre-launch Assessment Review (PAR) Panel

The PAR process is a series of incremental OSMA reviews held for each Space Shuttle mission and presented to senior SMA management. During this process, appropriate assessments are presented by program SMA personnel to certify that the SMA organizations have satisfactorily fulfilled the requirement to perform in-line assurance oversight and independent assessments of changes in risks associated with Space Shuttle hardware, software, processes, and operations. These assessments are performed to verify that the program properly addresses safety and mission assurance. The incremental PAR reviews and the readiness statements signed at the completion of the reviews relate directly to the presentation subject matter. The Certification of Flight Readiness endorsements by SMA organizations and AA/OSMA are based on results of the assessments made in support of the PAR process and the developed rationale for flight. The PAR is chartered by NSTS 22778, "Commit to Flight Assessment Review Process Operating Plan."

1.11.10 Payload Safety Review Panel.

This panel is established by the Manager, Space Shuttle Program, and the Manager, International Space Station Program, to review the flight safety aspects of Space Shuttle payloads and International Space Station experiments and cargo. The panel is responsible for conducting safety reviews as defined in NSTS/ISS 13830C, "Payload Safety Review and Data Submittal Requirements for Payloads using the Space Shuttle and International Space Station." The panel is responsible for assuring the implementation of NSTS 1700.7B, "Safety Policy and Requirements for Payloads Using the Space Transportation System," and NSTS 1700.7B Addendum, "Safety Policy and Requirements for Payloads Using the International Space Station." See JSC Policy Charter, JPC 1152.4K, "Space Shuttle Payload Safety Review Panel (PSRP)," for further details.

1.11.11 Ground Safety Review Panel.

This panel is established to review the ground safety aspects of Space Shuttle payloads and International Space Station flight hardware, experiments, and cargo. The panel is responsible for conducting safety reviews as defined in NSTS/ISS 13830C, "Payload Safety Review and Data Submittal Requirements for Payloads using the Space Shuttle and International Space Station," and SSP 30599, "Safety Review Process." The panel is responsible for assuring the implementation of KHB 1700.7, "Kennedy Space Center Payload Ground Safety Handbook." See KMI 1150.24, "Ground Safety Review Panel," for further details.

1.11.12 ISS Safety Review Panel.

This panel is established to review the safety aspects of International Space Station flight hardware during the launch, return, and on-orbit mission phases as well as the safety of any visiting vehicles. This panel is co-chaired by representatives of the Space Shuttle and International Space Station programs. The panel is responsible for conducting safety reviews as defined in SSP 30599, "Safety Review Process." The panel is responsible for assuring the implementation of SSP 50021, "Safety Requirements Document." More details can be found in the ISS Safety Review Panel Charter.

1.11.13 Ad Hoc Committees.

Center Directors and the Associate Administrator for Safety and Mission Assurance may establish ad hoc committees to provide safety oversight review of programs, projects, and other activities.

1.12 Coordination with Organizations External to NASA

1.12.1 The Office of Safety and Mission Assurance, in close coordination with the Office of Policy and Plans (for exchanges with other U.S. Government agencies and private entities) and with the Office of

External Relations (for exchanges with the Department of Defense, intelligence agencies, and foreign entities) and in consultation with the NASA Office of General Counsel, shall establish guidelines for exchanging safety information. New and different methods and practices that may be beneficial to the NASA Safety Program should be brought to the attention of the responsible Headquarters Office by those that may encounter these practices used outside NASA.

1.12.2 Participation by NASA safety professionals in outside safety-related professional organizations is encouraged. Examples are functions and committees of the National Safety Council, National Fire Protection Association, DOD Explosive Safety Board, National Academy of Sciences, System Safety Society, Federal Agency Committee on Safety and Health (FACOSH), American Society of Safety Engineers, Field Federal Safety and Health Councils, and the Joint Army, Navy, NASA, Air Force (JANNAF) propulsion committee (and subcommittee).

1.13 Emergency Planning

1.13.1 The NASA Emergency Preparedness Plan is NASA's part of the Government program to maintain critical Government functions during national emergencies ranging in severity from fires and civil riots to a full-scale military attack on the United States. Emergency plans shall be in place, discussed with the appropriate personnel, and exercised periodically for all NASA activities so that reaction to emergency situations is rapid and effective. Such plans will cover the response to national and local emergencies, disasters, and mishaps, and the attendant communication of information.

1.13.2 NPD 8710.1, "Emergency Preparedness Program Policy," and NPG 8715.x, "NASA Emergency Preparedness Program Plan Procedures and Guidelines," establish NASA policy, requirements, and procedures in this regard. Center Directors are responsible for preparing their organizations to handle emergencies and disasters effectively and for developing the Center emergency plan.

1.14 Safety Motivation and Awards Program

The following paragraphs provide a policy overview and identify the responsibilities and the primary types of safety performance to be recognized.

1.14.1 NASA is committed to continued improvement of safety in all operations. NASA's policy is to stimulate the participation of employees in this effort. The presentation of awards is considered appropriate for recognizing outstanding safety-related performance/contributions and is an effective means of encouraging safety excellence.

1.14.2 NASA recognizes responsible individuals and organizations for the following:

1.14.2.1 Taking significant safety initiatives.

1.14.2.2 Making truly innovative safety suggestions.

1.14.2.3 Meeting major safety goals.

1.14.2.4 Making significant achievements leading to the safer and more effective use of resources or execution of NASA operations.

1.14.2.5 Encouraging and rewarding safety excellence among employees (applies to supervisors).

1.14.3 NASA safety awards shall recognize the safety achievements of NASA and other Federal Government employees supporting NASA objectives in all occupational categories and grade levels. NASA safety awards programs also may provide for the recognition of non-Government personnel (e.g., JPL employees) supporting NASA objectives.

1.14.4. The Space Flight Awareness (SFA) Employee Motivation and Recognition Program for NASA, supporting Government agencies, private industry, and international organizations, promotes safety, particularly for human space flight programs. The goal of this program is to instill in employees the need to reduce human errors and mistakes that could lead to space flight mishaps and mission failure.

1.15 Safety Management Information

Efficient communication of safety information is necessary to meet the needs of safety officials and the managers they support. This includes communications between and among operational and safety organizations. NASA safety organizations will pursue every practical means for communicating verbal and written safety management information, lessons learned, and statistics. Examples of NASA information systems are the Incident Reporting Information System (IRIS) and the Lessons Learned Information System (LLIS). Records and reports of accidents, occupational injuries, incidents, failure analyses, identified hazards, mishaps, appraisals, and like items contain information necessary for developing corrective measures and lessons learned.

1.15.1 Recordkeeping and Reporting Requirements.

NASA shall maintain detailed records of occupational injuries that are reported to OSHA in accordance with 29 CFR 1960, Subpart I, "Recordkeeping and Reporting Requirements," and NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping." Detailed information is provided in NPD 3810.1, "Processing Claims Under the Federal Employees Compensation Act." Safety forms and reports are retained per NPG 1441.1, "NASA Records Retention Schedules."

1.15.1.1 Employees are allowed access to these data and their medical exposure records in accordance with Federal regulations (29 CFR 1960).

1.15.1.2 NASA also publishes a periodic Safety Program Status Report for internal Agency use.

1.15.2 Furnishing of Documents to NASA Headquarters.

The following documents shall be provided or made accessible (through internet web site) to the Director, Safety and Risk Management Division:

1.15.2.1 Center executive safety committee or board documentation (e.g., minutes and reports).

1.15.2.2 Results of external (such as OSHA) safety program management reviews.

1.15.2.3 Top-level Center or program safety procedure documents that implement Headquarters requirements. Electronic versions or web addresses are acceptable and should be forwarded in conjunction with the data for the annual report.

1.15.2.4 Major mishap reports as required by NPD 8621.1, "NASA Mishap Reporting and Investigating Policy," and information as requested by Headquarters in NPG 8621.x, "NASA Procedures and

Guidelines for Mishap Reporting, Investigating, and Recordkeeping."

1.15.2.5 Copies of comments sent to outside regulatory agencies (e.g., OSHA, Department of Transportation (DOT), Environmental Protection Agency (EPA)) concerning proposed rule-making that could affect the NASA Safety Program.

1.15.2.6 In conjunction with the input for the annual report, a summary of open safety abatement plans and variances and a listing of those closed during the reporting period.

1.15.2.7 Copies of safety variances granted at the Center or the program/project level (see paragraph 1.20).

1.15.3 Safety managers will maintain an approximate census of Government and contract employees by organization or contractor company.

1.16 Safety Lessons Learned

Safety lessons learned during the performance of management and technical functional activities or mishap or close call investigations shall be developed and disseminated to program managers and throughout NASA Centers and Headquarters by cognizant personnel to improve understanding of hazards, prevent the occurrence of accidents, and suggest better ways of implementing system safety programs. In addition to contributing appropriate information to the LLIS, safety managers will include this information in program, procurement, and Center newsletters to communicate more effectively with management. Lessons learned that indicate the need to revise source documents (e.g., policies, procedures, specifications, and standards) shall be submitted directly to the person(s) preparing the document. The LLIS will provide a library of lessons learned data for use by program managers, design engineers, operations personnel, and safety personnel. Procedures for disseminating lessons learned can be found at the following Internet address: http://llis.nasa.gov/.

1.17 NASA Safety Reporting System (NSRS)

The NSRS is a confidential, voluntary, and responsive safety reporting system that provides a direct channel for NASA employees and contractors to notify the Safety and Risk Management Division of safety concerns. The NSRS enables safety personnel to identify safety problems and implement corrective actions independently. The nature of corrective actions may be engineering, manufacturing, administrative, procedural, or operational. All involved safety professionals having timely information about actual hazards is of the highest priority. The NSRS has been established to collect, evaluate, and communicate such information in a timely and accurate manner. It is intended to supplement, not replace, existing local hazard reporting systems when those systems do not resolve an individual's safety concerns.

Information about the NSRS and a copy of the NSRS form can be found at the following Internet address: http://www.hq.nasa.gov/office/codeq/nsrsindx.htm.

The NSRS will be implemented at all NASA Centers. NASA contracting officers are encouraged to implement the NSRS program at contractor facilities by citing the NASA FAR Supplement Clause (NFS 1852.223-70). Pre-addressed postage-paid forms can be obtained at any Center Safety Office. Forms should be mailed to:

NASA SAFETY REPORTING SYSTEM

PO BOX 6037
FALLS CHURCH, VA 22040-9824

1.18 Safety Documentation

1.18.1 The goals of the Safety and Risk Management Division documentation effort are to update and clarify top policy directives, separate policy from guidance, and reduce repetition and cross-linking between directives.

1.18.2 The documentation tree represents the Safety and Mission Assurance top level NASA Policy Directives, NASA Procedures and Guidelines, applicable NASA Technical Standards, and other top level documents in the NASA Safety Program. The Safety and Mission Assurance documentation tree is posted on the Internet at: http://www.hq.nasa.gov/office/codeq/qdoc.pdf.

1.19 Safety Variance Process

1.19.1 The primary objective of the NASA safety variance policy is to define the roles of Headquarters, Centers, program managers, and safety personnel in such a way that Headquarters will maintain control over the requirements it sets while providing the Centers and program managers with the responsibility and freedom to accept risks necessary to accomplish their tasks. This is consistent with an ISO 9001 requirement of maintaining process control of services that an organization provides. It is NASA's preference to comply with requirements through an abatement process. Where this is impossible for whatever reason, then a variance may be considered.

1.19.1.1 The following definitions apply to the NASA safety variance approval policy:

a. Variance: Documented and approved permission to perform some act or operation contrary to established requirements.

b. Deviation: A documented variance that authorizes departure from a particular safety requirement that does not strictly apply or where the intent of the requirement is being met through alternate means that provide an equivalent level of safety with no additional risk. The OSHA term for deviation is alternate or supplemental standard only when it applies to OSHA requirements.

c. Waiver: A variance that authorizes departure from a specific safety requirement where a special level of risk has been documented and accepted.

d. Shall: The word "shall" indicates that the rule is mandatory. Noncompliance with a "shall" statement requires approval of a variance. Use of the word "shall" is preferred when writing mandatory NASA safety requirements; however, the words "will" and "must" are used at times to indicate mandatory requirements and have the same interpretation as "shall."

e. Should: The word "should" indicates that the rule is a recommendation, the advisability of which depends on the facts in each situation. Implementation of a "should" statement is at the discretion of the local officials.

1.19.1.2 The NASA variance process does not apply to Federal and applicable State/local regulations (e.g., OSHA, Cal OSHA). Any variance of a Federal or State/local regulation must be approved by the appropriate Federal/State/local agency (e.g., NASA Alternate Safety Standard for Suspended Load Operations approved by OSHA). The Safety and Risk Management Division shall review all proposed safety variances of Federal regulations before submittal for approval.

1.19.1.3 The NASA Headquarters safety variance policy is provided in Table 1.1. It applies to all Agency safety requirements unless otherwise specified in the appropriate requirements document. Variance policies developed for specific safety programs shall follow this general policy as closely as possible.

1.19.1.4 When a variance is approved by Headquarters and is considered appropriate for use throughout the Agency, it shall be distributed as an interim change to the applicable requirements document(s).

1.19.1.5 All requests for variance will be accompanied by documentation as to why the requirement can not be met, the risks involved, alternative means to reduce the hazard or risk, the duration of the variance, and comments from any affected employees or their representatives (if the variance affects personal safety). Variances will normally be approved by the Safety and Risk Management Division for up to 5 years. Variances approved at the Center or program level can remain in place as long as Headquarters status reporting is current.

Table 1.1 - NASA Safety Risk Acceptance and Approval Process Matrix

Type of Document	Wording	Require-ment Specified In:	Routing (see Note A)	Approval Level and duration (see Note B)	After Action Reporting and Statusing Requirements
Federal	Policy	N/A	Through Program System Safety Manager or Center Safety Director, Center Director and NASA HQ/QS in-turn	Issuing Federal Agency	Assessed and statused annually with input for OSHA report
State	Policy	N/A	Through Program System Safety Manager or Center Safety Director and Center Director	Issuing State Agency	Assessed and statused annually with input for OSHA report
NPD	Policy	N/A	Through Program System Safety Manager or Center Safety Director and Center Director	NASA HQ IPO or Enterprise	Assessed and statused annually with input for OSHA report
NPG	Shall	N/A	Through Program System Safety Manager or Center Safety Director	Center Director *	To NASA HQ/QS within 14 days and then assessed and statused annually with input for OSHA report
NPG	Should	N/A	Through Program System Safety Manager or Center Safety	Directorate level Facility Manager or Program	To NASA HQ/QS

			Director	Manager	Quarterly and then assessed and statused annually with input for OSHA report
Standard	Shall	NPD	Through Program System Safety Manager or Center Safety Director and Center Director	NASA HQ IPO or Enterprise	Assessed and statused annually with input for OSHA report
Standard	Shall	NPG	Through Program System Safety Manager or Center Safety Director	Center Director *	To NASA HQ/QS within 14 days and then statused annually with input for OSHA report
Standard	Should	N/A	Through Program System Safety Manager or Center Safety Director	Program or facility manager	Not required

Note A: The lowest organizational or program level of management having responsibility to implement safety requirements (e.g. facility manager, program systems manager, first line supervisory personnel) will assess, prepare, and submit a variance request through the appropriate levels of authority to the official with final approval authority. Safety officials (both program and Center as applicable) will concur or nonconcur with the request but will not serve as the responsible approving official.

Note B: Using the guidelines of this matrix, the final approval is the responsibility of the listed manager or director who, by their position, has the authority to accept the risk. Variances approved against mandatory ("shall") requirements are valid for up to 5 years. Variances approved against advisory ("should") provisions at the directorate or program level can remain in place as long as annual assessment and reporting is maintained.

Example: A *variance request* to a requirement stated in an *NPG* (fourth row of matrix) that uses the word *shall* would be routed *through the Center Safety Director* for concurrence and *approved or denied by the Center Director*. A copy would then be *sent to NASA HQ/QS within 14 days* along with the detailed rationale for its approval and other documentation. Annual status reports will be provided to HQ/QS concurrently with the input to the annual OSHA report.

*Approval is allowed at this level if the specific requirement is not implementing Federal regulatory policy. In those cases, forward to NASA HQ/QS for variance request to applicable Federal agency.

CHAPTER 2. Safety and Risk Management Considerations for NASA Contracts

2.1 Purpose

This chapter describes the general approach for assuring that NASA contractors have effective safety and risk management programs. The chapter provides guidance for NASA officials with responsibility for assuring safety under NASA contracts

2.2 Applicability and Scope

When NASA activities include contractor involvement, the NASA Safety Program must include contractors. NASA contracts must be written to hold contractors accountable for the safety of their employees, their services, and their products (as applicable). The contracting officer (CO) and the cognizant NASA safety officer shall assure that the requirements of this NPG are included in contracts.

2.3 Authority and Responsibility

The contracting officer (CO) and the cognizant NASA safety official shall assure that the requirements of this NPG are included in NASA contracts. Those requirements must be coordinated with the program or project office, and other offices as needed.

2.3.1 Program and project managers shall perform the following:

a. Coordinate with the cognizant safety officials to develop and approve safety requirements and objectives for efforts to be contracted and advise CO`s of these specific safety concerns or issues related to the contract performance.

b. Develop safety requirements and objectives that are clearly delineated in the specifications. Provide specific tasks to the contracting officer for incorporation into the contract as required.

c. Tailor surveillance of contractor safety matters appropriate to the nature of the procurement. (Even a performance-based contract must have a surveillance plan.)

d. Where appropriate, include safety as an element under Mission Suitability and/or Past Performance in the Source Selection Plan.

2.3.2 CO`s shall perform the following:

a. Coordinate any matters regarding proposed deviations to safety requirements of NFS Subpart 1823.70, "Safety and Health," with the Director, Safety and Risk Management Division, or his/her designated representative.

b. Establish safety performance, where appropriate, as an element to be evaluated in contracts with fee plans.

c. Require copies of Material Safety Data Sheets (MSDS) for new hazardous materials where requested by the local NASA safety office. Contractors` hazard analyses/safety risk assessment will be developed and provided to NASA for approval before the start of any hazardous deliverable work or support operations as directed by the Contracting Officer or the Contracting Officer`s Technical Representative (COTR).

2.3.3 Center safety and mission assurance officials must be familiar with the NFS (NPG 5100.4, "Federal Acquisition Regulation Supplement (NASA/FAR Supplement)"). In particular, they should be expert in Parts 1807, Acquisition Planning; 1823, Environmental, Conservation, Occupational Safety, and Drug-Free Workplace; 1842, Contract Administration; and 1846, Quality Assurance.

2.3.4 Safety and mission assurance personnel shall perform the following:

a. Participate in the development of the safety tasks and requirements in conjunction with program officials.

b. Participate in onsite visits and pre-bid conferences to ensure potential bidders understand safety provisions.

c. Assist the CO in evaluating the safety record of the prospective contractors.

d. Assist the CO as appropriate in evaluating the contractor`s performance regarding safety.

e. Assist the CO as appropriate in applying any special safety provisions to grants or cooperative agreements (see paragraph 2.7).

2.4 Requirements

2.4.1 Contracts will contain safety and mission success and risk management requirements as appropriate for design, development, fabrication, test, or operations of systems, equipment, and facilities.

2.4.2 Where appropriate, solicitations will require the submission and evaluation of safety and risk management documentation (e.g., corporate safety policies, implementation procedures, their safety performance experience, and their mishap rates by SIC codes) and draft program planning documents, such as safety and health plans, risk management plans, etc. (See Chapter 3, Appendix H, and Appendix I for more information.)

2.4.3 On a case-by-case basis and before contract performance begins, cognizant NASA Safety Officers will brief onsite contractors on local safety requirements and document these briefings. As a minimum, the briefing will include incident and accident reporting, base emergency evacuation procedures, fire reporting, medical emergency notification, hazardous material spill reporting and response, site entry/exit procedures, and hot work permit requirements. The cognizant NASA Safety Officer will also inform the onsite contractor of any adjacent NASA and other contractor operations that could pose a hazard to their operation and employees, and the CO and the cognizant safety officer shall ensure that the contract includes a provision to require the contractor to provide a written plan for mitigating those hazards.

2.4.4 To the extent specified in the contract, contractors shall develop motivation, awareness, training, and certification programs for their employees in safety matters (see Chapter 4). This will include regularly scheduled safety meetings for supervisors, foremen, and employees. Contractors will document safety-related training in accordance with OSHA requirements and as specified in the contract.

2.4.5 To the extent specified in the contract, contractors shall report safety data on mishaps, close calls, and lessons learned as required in NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping," and in accordance with OSHA requirements. Investigation of contractor mishaps will be performed in accordance with investigation procedures as specified in the contractor`s safety plan. The Contracting Officer or the COTR will evaluate and verify implementation of corrective actions.

2.4.6 To the extent specified in the contract, contractors shall monitor and self-evaluate activities for compliance with the safety provisions or requirements of the contract. Contractor activities also will be properly monitored and evaluated by NASA officials (or delegated agencies). These safety program reviews will be conducted to identify and correct any safety problems at an early stage.

2.4.7 Center safety offices shall assist the program or project manager or other responsible official in implementing contractor safety surveillance and evaluation programs. The depth of insight and oversight employed will fit the extent of hazards and the importance of the program.

2.4.8 To the extent specified in the contract, contractors shall provide the Contracting Officer or safety officials with access to their activities to determine the adequacy of safety measures. Contractors shall also provide access for NASA Headquarters and Center safety program review teams for them to conduct selected announced and unannounced reviews of contractor operations.

2.4.9 To the extent specified in the contract, contractors located on NASA facilities shall comply with Center safety and emergency planning requirements. Contractors shall document their emergency points of contact and safety responsibilities for all operations with safety implications.

2.4.10 To the extent specified in the prime contract, contractors shall include safety responsibilities in subcontracts.

2.4.11 To the extent specified in the contract, contractors shall assess all Government-Furnished Property (GFP) or Facilities (GFF) associated with the contract and advise the Contracting Officer of areas not in compliance with OSHA standards.

2.5 Access to NASA Facilities by State or Federal Compliance Safety and Health Officers

2.5.1 Compliance safety and health officers are persons authorized by the OSHA, U.S. Department of Labor (DOL), to conduct inspections. Federal (OSHA) or State compliance safety and health officers will be allowed on NASA Centers to review and survey contractor operations and investigate mishaps. If the State does not have a DOL-approved safety plan or the Center is under exclusive Federal jurisdiction, only Federal compliance officers shall have the right of access to NASA or contractor operations.

2.5.2 Unless exclusive Federal jurisdiction is claimed by Federal OSHA, both Federal and State OSHA investigators will be allowed to investigate a contractor mishap occurring on a NASA Center. The Safety and Risk Management Division or the Office of Heath Affairs as applicable and the DASHO shall be notified of OSHA`s (Federal or State) impending investigation and shall be provided the results of their investigation.

2.6 Contractor Citations

Under the Occupational Safety and Health Act of 1970 (P.L. 91-596), as amended, an employer is responsible for providing employees with safe working conditions regardless of where the employees are working. Therefore, it is the contractor`s responsibility to submit a timely reply to any OSHA citation it receives. The contractor is responsible for settling citations issued against the operation unless specifically addressed in the contract.

2.7 Grants

A "special safety condition" addressing safety should be included in grants and cooperative agreements when performance involves NASA facilities, Government-Furnished Equipment (GFE), or hazardous or energetic materials or chemicals that may pose a significant safety or health risk when used. Program offices that select research projects that could contain possible safety issues shall identify the need for a safety special condition to be included in the grant or cooperative agreement award document. The special safety condition shall include the provision that all applicable OSHA requirements, host institution, and general industry accepted practices shall be followed during the research to eliminate or control the risks associated with the grant or cooperative agreement.

CHAPTER 3. System Safety

3.1 Purpose

This chapter establishes procedures and guidelines for the implementation of system safety processes to ensure the identification and reduction of program safety risks to an acceptable level to enhance mission success.

3.2 Applicability and Scope

3.2.1 For simplicity, "programs" shall be interpreted to include programs, projects, and acquisitions. When the work is performed in-house at NASA, the term Contractor shall be interpreted to apply to the in-house activity.

3.2.2 NASA requires system safety tasks for systems acquisitions, in-house developments, facility design/modifications, and Agency operations and activities. For joint ventures between NASA and other parties including commercial services, interagency efforts, and international partnerships, application of these practices shall be as specified in related contracts, memoranda of understanding, NPD`s, or other documents, and will consider the degree of NASA responsibility in the venture.

3.2.3 The program/project manager, in conjunction with the local safety and mission assurance organization, shall determine minimum mission success criteria. He or she will then determine the degree to which specific procedures, guidelines, and requirements contained in this chapter are implemented. They shall consider the potential for personnel injury, mission failure, equipment loss or facility damage, or property damage, the impact to cost and schedule, and the visibility of the program to the public. The process is called "tailoring." The final mission success planning activity will be documented and approved as an element of the risk management planning portion of the program plan. A safety plan may be requested as a separate document. A sample format is shown in Appendix H. (See NPG 7120.5, "Program and Project Management Process and Requirements," paragraph 4.5.1.2.)

3.2.4 Tailored system safety activities shall be planned and documented during the formulation phase for the following:

a. Aeronautical systems.

b. Human crewed and robotic space flight systems.

c. Payloads (spacecraft, internal and external payloads, and experiments flown on aircraft, Space Shuttles, International Space Station, Expendable Launch Vehicles (ELV`s), balloons, and sounding rockets).

d. Major facilities acquisition programs.

e. Support equipment, including ground and airborne, test, maintenance, and training equipment.

f. Related safety-critical software.

3.2.5 A systematic approach to safety should also be applied to operations and supporting activities including construction, fabrication and manufacture, experimentation and test, packaging and transportation, storage, checkout, launch, flight, use, reentry, retrieval and disassembly, maintenance and refurbishment, modification, and disposal.

3.2.6 Programs with existing approved system safety tasks containing adequate definition of the risk assessment and management process are not required to comply with any new requirements of this chapter, but any changes made in their system safety task must comply with this chapter. This chapter shall not supersede or prevent the application of more stringent requirements imposed by programs.

3.3 Objective

The principal objective of a system safety activity is to provide for an organized, disciplined approach to the early identification and resolution of hazards impacting personnel, hardware, or mission success to a level as low as reasonably achievable (ALARA). The system safety activity will use the 5-step risk management approach shown in figure 3.1. (See NPG 7120.5, "Program and Project Management Process and Requirements," paragraph 4.2.) The five steps of the risk management approach are as follows:

3.3.1 Identify and document the system safety and mission success risks (hazards) early in the program and continue to update the status of these risks and any newly identified risks through out the program or project.

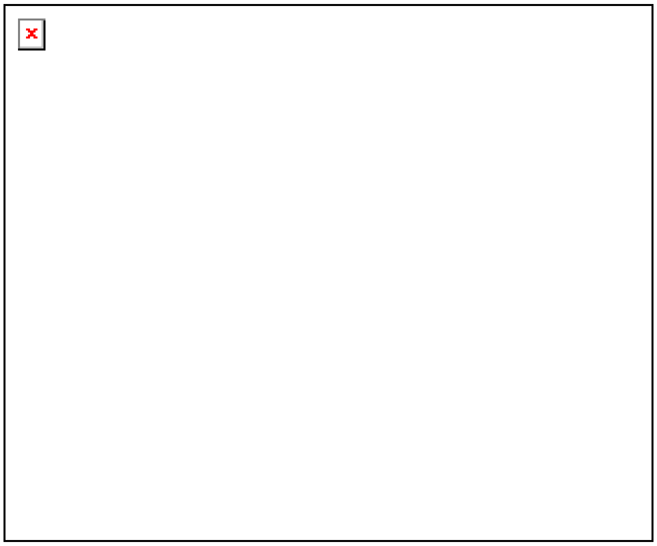


Figure 3.1 Continuous Risk Management Process

3.3.2 Analyze the risks (hazards) for probability, impact/severity, and time frame. When that is complete, prioritize the risks.

3.3.3 Plan what should be done to eliminate or reduce the risks, and provide the planning and decisionmaking documentation to the appropriate levels of program management for a decision to eliminate, further reduce, or accept the risk. Institute hazard mitigation (corrective) actions.

3.3.4 Track the results of the corrective actions and continue to verify and validate their effectiveness.

3.3.5 Control or change the corrective action plans based on the effectiveness of the mitigation actions.

3.4 Hazard Reduction Protocol

Hazards will be mitigated according to the following stated order of precedence:

3.4.1 Eliminate hazards.

3.4.2 Design for minimum hazards.

3.4.3 Incorporate safety devices.

3.4.4 Provide caution and warning devices.

3.4.5 Develop administrative procedures and training.

(Note 1: Providing protective clothing and equipment is considered an administrative procedure.)

(Note 2: Some hazards may require the combination of several of these approaches to mitigation.)

3.5 Responsibilities

3.5.1 Program/project managers (or equivalent) shall do the following:

3.5.1.1 Implement a tailored system safety and mission success activity based on the loss potential of the program and provide adequate resources to achieve the safety objectives. Depending upon complexity, a program will typically budget 3 to 5 percent of direct engineering and operations staff hours to support safety and mission assurance requirements.

3.5.1.2 Assign a System Safety Manager (SSM) (e.g., product assurance manager, flight safety manager, or flight assurance manager), in coordination with the Center Safety and Mission Assurance (SMA) Director, to have specific responsibility for executing the system safety tasks within the project. The onsite SSM will report to the program/project manager for program direction and to the Center SMA Director for policy and functional direction.

3.5.1.3 Implement and maintain the system safety and mission success planning portion of the risk management activity of the program plan with guidance and assistance from the local SMA organization. A separate stand-alone safety plan may be requested.

3.5.1.4 Ensure that system safety analyses appropriate to program complexity have been conducted. These analyses must include early interaction with the engineering, integration, and operations functions to ensure all hazards are identified and documented. The NASA Lessons Learned Information System (LLIS) and NTM 4322, "NASA Reliability Preferred Practices for Design and Test," will be used to supplement the normal program hazard assessment process.

3.5.1.5 Perform system safety and mission success reviews of the program. The greater the potential risks (e.g. complexity or visibility of the programs), the greater the independence and formality of the review required. Major programs such as the Space Shuttle or the International Space Station will have dedicated independent assessment activities.

3.5.1.6 Establish a formal, closed loop, risk acceptance process to identify and track program hazards with residual risk. Ensure residual risks are accepted in writing. Regardless of the size of the program, only the program/project manager or system acquisition manager is permitted to accept residual critical and catastrophic safety risks. A sample format for risk identification, assessment, and approval is in Appendix E. In all cases, where a decision is made to accept a risk, that decision will be coordinated with the governing SMA organization and communicated to the next higher level of management for review.

3.5.1.7 Issue program directives, specifications, and standards that provide uniform and systematic application of safety policy and requirements.

3.5.1.8 Assign sufficient numbers of personnel of appropriate experience and skills to perform system safety tasks. Provide training when necessary.

3.5.2 Assigned system safety managers shall do the following:

3.5.2.1 Possess appropriate technical and managerial training and expertise for conducting an effective safety process.

3.5.2.2 Advise the program/project manager regarding NASA requirements for and status of the tailored system safety task.

3.5.2.3 Manage the system safety task for the program/project manager through the following:

a. Assist the program/project manager in the development, documentation, and implementation of the system safety and mission success activity in the program plan.

b. Organize the system safety effort to ensure maximum effectiveness in interacting with engineering, operations, integration, and program management.

c. Ensure specific safety requirements are integrated into overall programmatic requirements, and are reflected in applicable specifications and planning documents.

d. Determine which required hazard analysis tools and techniques (see Appendix D) will be used to ensure compliance with NASA and program safety policy and directives and when they will be used to produce safety and mission assurance documentation. Ensure the selected tools and techniques are used in an iterative process to identify all program hazards, causes, detailed control requirements, and control verifications.

e. Determine reporting requirements for all levels of the originating organization to support the system safety task (i.e., contractor, element, or NASA organization). Establish criteria for submittal (milestone, periodic, event), format, and distribution, and ensure the program provides for submittal of the required reports.

f. Assist the program/project manager in documenting and communicating the acceptance of risks.

3.5.2.4 Conduct periodic independent reviews of the system safety tasks keyed to program milestones.

3.5.2.5 Assist and support independent review groups chartered to provide independent assessment of the program.

3.5.2.6 Maintain an up-to-date database of identified hazards throughout the life of the program.

3.5.2.7 Maintain the appropriate safety oversight or insight of the program tests, operations, or activities at a level consistent with mishap potential for the life of the program.

3.5.2.8 Establish an independent safety reporting path (see NPD 8700.1, "NASA Policy for Safety and Mission Success") to keep the OSMA apprised of the system safety status, particularly regarding problem areas that may require assistance from Headquarters.

3.5.2.9 Support the OSMA independent safety assessment process (e.g., Space Shuttle Pre-launch Assessment Reviews, International Space Station Design and Assessment Reviews) to determine readiness to conduct tests and operations having significant levels of safety risks, and provide real-time safety assessments to the OSMA, when appropriate, while tests and operations are in progress.

3.6 Hazard Assessment

The hazard assessment process is a principal factor in the understanding and management of technical risk. Hazards are identified and resultant risks are assessed by considering probability of occurrence and severity of consequence. Risk may be assessed qualitatively or quantitatively. System safety is an integral part of the overall program risk management decision process. A sample format to document the risk process is provided in Appendix E.

3.6.1 Risk Assessment Code (RAC). The RAC is a numerical expression of comparative risk determined by an evaluation of both the potential severity of a condition and the probability of its occurrence. RAC`s are assigned a number from 1 to 7 in a risk matrix (see figure 3.2.). The RAC number will serve as a means to prioritize corrective actions, e.g., RAC 1 is unacceptable and mitigation actions must be taken immediately or operations terminated, RAC 2`s must be addressed before RAC 3`s, etc. Differences between higher number RAC`s (beyond 4) probably cannot be discerned due to low risk levels. The cognizant safety and program officials may approve variations to the matrix.

3.6.1.1 Severity is an assessment of the worst potential consequence, defined by degree of injury or property damage, which could occur. The severity classifications are defined as follows:

Class I - Catastrophic - A condition that may cause death or permanently disabling injury, facility destruction on the ground, or loss of crew, major systems, or vehicle during the mission.

Class II - Critical - A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, equipment, or flight hardware.

Class III - Moderate - A condition that may cause minor injury or occupational illness, or minor property damage to facilities, systems, equipment, or flight hardware.

Class IV - Negligible - A condition that could cause the need for minor first aid treatment though would not adversely affect personal safety or health. A condition that subjects facilities, equipment, or flight hardware to more than normal wear and tear.

3.6.1.2 Probability is the likelihood that an identified hazard will result in a mishap, based on an assessment of such factors as location, exposure in terms of cycles or hours of operation, and affected population. The following is an example of Probability Estimation:

A - Likely to occur immediately. ($X > 10^{-1}$)

B - Probably will occur in time. ($10^{-1} \geq X > 10^{-2}$)

C - May occur in time. ($10^{-2} \geq X > 10^{-3}$)

D - Unlikely to occur. ($10^{-3} \geq X > 10^{-6}$)

E - Improbable to occur. ($10^{-6} \geq X$)

(derived from Mil Std 882-System Safety Program Requirements)

	Probability Estimate				
Severity Class	A	B	C	D	E
I	1	1	2	3	4
II	1	2	3	4	5
III	2	3	4	5	6

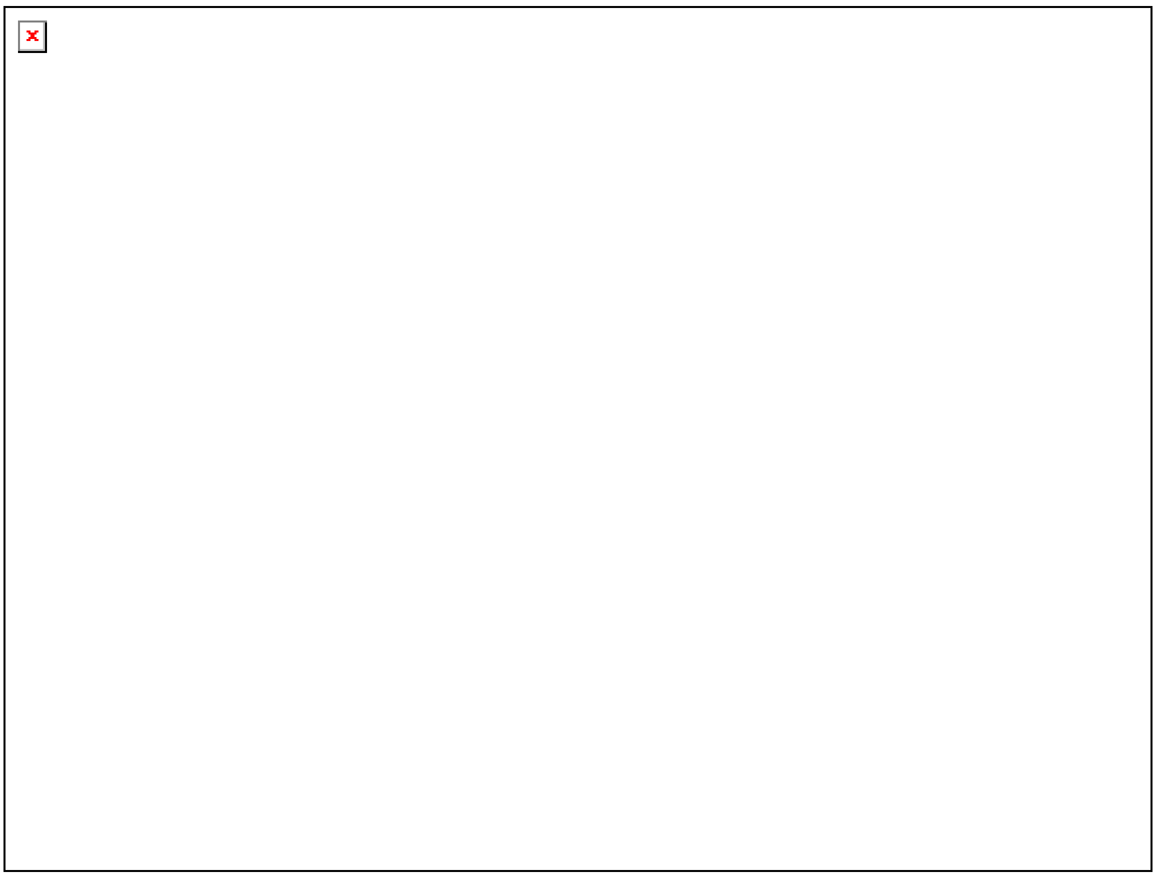
IV	3	4	5	6	7

Figure 3.2 Risk Assessment Code Matrix

(See paragraph 3.6.1 for RAC usage.)

3.7 Safety Activity Phases

As presented in figure 3.3, the hazard assessment process begins in the formulation stage and continues, in varying degrees, throughout the program`s life cycle. This involvement begins with the early design concepts. The system safety and mission success hazard analysis effort shall be a continuing and iterative process influencing the system in a manner which manages risk as the design progresses and matures.



3.8 System Safety and Mission Success Hazard Analyses

3.8.1 System safety analyses provide a means to systematically and objectively identify hazards, determine their risk level, and suggest the mechanism for their elimination or control. This iterative process begins in the conceptual phase and extends throughout the life cycle including disposal. The extent and depth of analysis required to meet the following five functions will be determined by system complexity and loss potential. Functions supported by the analyses include the following:

3.8.1.1 Providing the foundation for the development of safety criteria and requirements.

3.8.1.2 Determining whether and how the safety criteria and requirements provided to engineering have been included in the design.

3.8.1.3 Determining whether the safety criteria and requirements created for design and operations have provided an acceptable level of risk for the system.

3.8.1.4 Providing a roadmap (or methodology) for the development of safety goals and mission success criteria.

3.8.1.5 Providing a means for demonstrating that safety goals have been met.

3.8.2 During the hazard identification process, it is essential to remain non-judgmental about the associated probability, severity, and corrective action. Once identified, hazards are ranked by severity, probability of occurrence, and program impact (risk assessment). Sufficient analyses are performed to assess the likelihood of occurrence (usually qualitative for early assessments) for each undesired event identified.

3.8.3 There are several types of analyses necessary to identify all the hazards, some of which are specialized and others which, as designs mature, build on previously accomplished analyses.

3.8.3.1 The first safety analysis is the Preliminary Hazard Analysis (PHA), which shall be performed early. Other primary analyses shall include the Subsystem Hazard Analysis (SSHA), Component Level Fault Tree Analysis (FTA), Software Hazard Analysis (SWHA) (see NASA Standard 8719.13A, "Software Safety," for more information), System Hazard Analysis (SHA), Operating and Support Hazard Analysis (O&SHA), Job Hazard Analysis (JHA), Human Factors Engineering Analysis, the Safety Requirements Compliance Matrix, and Integrated Hazard Analysis (IHA), unless otherwise indicated by the PHA. Data from these analyses can be used to offer recommendations to reduce risks.

3.8.3.2 The hazard analyses should use data developed by other types of analyses when available, such as the Failure Modes and Effects Analysis/Critical Items Lists (FMEA/CIL), Operations Analysis, Human Factors Engineering Analysis, and Maintainability Analysis. The safety analyst may have to develop specific, limited data to support the hazard analyses if the other analyses are not performed. FMEA/CIL analyses support, but are not an alternative to, the system safety analyses in paragraph 3.8.3.1. See Appendix D for further information on these analysis processes and techniques.

3.9 System Safety and Mission Success Program Reviews

The program/project manager, or his designated agent, shall conduct one or more system safety and mission success reviews depending on the complexity of the system. These reviews may be in conjunction with other program milestones. The purpose of these reviews is to evaluate the status of hazard analyses, residual risks, hazard controls, verification techniques, technical safety requirements, and program implementation throughout all the phases of the system life cycle. These reviews shall focus on the evaluation of management and technical documentation and the safety residual risks remaining in the program at that stage of development.

3.10 Documentation

3.10.1 The system safety task requires creation and maintenance of documentation that provides ready traceability from the baseline safety requirements, criteria, and effort planned in the conceptual phases through the life cycle of the program. All pertinent details of the hazard analysis and review shall be traceable from the initial identification of the hazard through its resolution and any updates, using the continuous risk management approach, until such time in the program as it is no longer applicable. Records shall be maintained per NPG 1441.1, "NASA Records Retention Schedules."

3.10.2 The SSM shall submit a report to management at each milestone (formulation, evaluation, implementation, or other equivalent milestones (PDR, CDR, DCR, and FRR, etc.)) detailing the results of the safety assessment to document the status of system safety tasks required by the program. In the report, the safety analyst shall do the following:

3.10.2.1 List residual risks baselined and potential risks that have yet to be resolved.

3.10.2.2 Document management and technical changes that affect the established safety baseline.

3.10.2.3 Document and verify adequate resolution of the hazards and obtain written acceptance of the risk from the program/project manager to complete the audit trail.

3.11 Change Review

Systems are changed during their life to enhance capabilities, provide more efficient operation, and incorporate new technology. With each change, the original safety aspects of the system could be impacted, either increasing or reducing the risk. Any aspect of controlling a hazard could be weakened, new hazards could be created, or conversely, hazards could be eliminated. Even a change that appears inconsequential could have significant impact on the baseline risk of the system. Accordingly, proposed system changes should be subjected to a safety review or analysis as appropriate to assess the safety impact. HR`s will be updated when required to show any identified risk change. Each change initiator shall ensure that safety personnel assess the potential safety impact of the proposed change and any changes to the baseline risk. Changes proposed to correct a safety problem shall also be analyzed to determine the amount of safety improvement (or detriment) that would actually result from incorporation of the change. There shall be a documented statement of safety impact for every change that is proposed to a program baseline (even if the statement is "No Impact).

CHAPTER 4. Safety Training and Personnel Certification

4.1 Purpose

Training must be provided to assist managers/supervisors and employees in their specific roles and responsibilities in the safety programs. Executive Order 12196, "Occupational Safety and Health Programs for Federal Employees," dated February 26, 1980, and 29 CFR 1960 (Subpart H) require that NASA establish comprehensive safety training programs. See NPG 8715.1, "Safety and Health Handbook - Occupational Safety and Health Programs."

This chapter describes the requirements for establishing safety training programs and minimum training certification levels necessary for personnel involved in potentially hazardous NASA operations. Much of this training is available on the Internet through the Site for On-line Learning and Resources (SOLAR) at: http://solar.msfc.nasa.gov. Instructor-based courses are available through the NASA Safety Training Center (NSTC). The list of training courses provided by the NSTC is also located on the SOLAR website. The NSTC can be reached by telephone at (281) 244-1284. This chapter also references personnel reliability program (PRP) requirements that may be imposed for certain mission critical job functions.

4.2 Responsibilities

4.2.1 Delegated Agency Personnel. Delegated Agency personnel (e.g., Defense Contract Management Command (DCMC)) used to enforce NASA activities shall meet the training requirements of the delegation or the appropriate accepted standards (e.g., DLAM 8280.1, "Specialized Safety Manual").

4.2.2 Center Training and Personnel Development Offices and Safety Offices. Center training and personnel development offices and safety offices will be jointly responsible for determining safety and certification training needs and overseeing those training efforts. Typical responsibilities are as follows:

4.2.2.1 Identification of training needs.

4.2.2.2 Identification of budget requirements for training.

4.2.2.3 Development of training courses and materials.

4.2.2.4 Assurance that training records reflect employee safety training.

4.2.3 Center Safety Official. The Center Safety Official shall develop required safety certification programs for the Center.

4.2.4 Line Organizations. Each line organization shall manage the certification program for its employees and contractors in accordance with procedures and guidelines in this document.

4.2.5 Medical Office. The medical office oversees or conducts the required personnel medical examinations in support of the safety certification effort and ensures compliance with Occupational Safety and Health Administration (OSHA) and other Federal, State, and local agency medical monitoring and recordkeeping requirements. The medical office shall determine the depth, scope, and frequency of medical examinations. The medical office is also responsible for medical certification in health hazard and related activities.

4.2.6 NASA Headquarters. The role of the Safety and Risk Management Division is to assist its Center counterparts in ensuring that 29 CFR Part 1960 requirements are followed and that appropriate Agencywide uniformity exists in the NASA safety training program. The Safety and Risk Management Division will act as a clearinghouse for information regarding available safety training courses and materials and it will develop, in conjunction with the Training and Development Division at NASA Headquarters, training courses suited to specific Agency safety needs. The Safety and Risk Management Division, in conjunction with the Office of Health Affairs at NASA Headquarters, will co-develop training courses and materials in areas of overlapping regulatory or programmatic responsibility.

4.3 Planning and Implementation

4.3.1 A comprehensive safety training program will be formulated by each Center. Center subject matter experts will review NASA training materials at least annually and update materials as needed when regulatory agencies or changes in NASA policy documents generate technical changes. The following should be considered in developing the safety training program for all employees:

4.3.1.1 OSHA, National Fire Protection Association (NFPA), Federal Aviation Administration (FAA), Environmental Protection Agency (EPA), emergency actions and contingency responses, and other appropriate training requirements and guidelines.

4.3.1.2 Identification of employee training groups within the Center population and determination of present training levels.

4.3.1.3 Identification of specific tasks, hazardous conditions, or specialized processes and equipment encountered by employees that would require safety training, e.g., certification training, cryogenic liquid carrier driver or hazardous waste operations, etc.

4.3.1.4 For each Center, a safety training program with written training syllabi, course objectives, and lesson plans that include lesson objectives, measurable desired learning outcomes, and formal evaluation instruments.

4.3.1.5 Identification and documentation of the planned training to be given to each employee category and the intended approach (course, literature, etc.). Refer to Appendix F for a suggested sample training schedule and career development plan.

4.3.1.6 Determination of the availability of safety training resources. A lack of a specific training resource will require the development of specialized training course materials.

4.3.1.7 Published training schedules.

4.3.1.8 Review and evaluation of training needs and schedules, and revision when necessary.

4.3.1.9 Hazard recognition training.

4.3.1.10 Training for safety committee members.

4.3.2 The Center safety office will maintain a current copy of the Center Safety Training Plan.

4.3.3 Each NASA Center will annually review operations being performed at the Center to ensure that the implemented safety training program is working effectively and to identify and enter into the program all those jobs that are potentially hazardous in addition to the mandatory listing in paragraph 4.6. Employee safety committees, employee representatives, and other interested groups should be provided an opportunity to assist in the identification process.

4.4 Personnel Safety Certification Program for Potentially Hazardous Operations and Materials

Many NASA operations involve hazardous materials or chemicals, technology, or systems with potential hazards to life, the environment, or property. People who perform or control hazardous operations or use or transport hazardous material must possess the necessary knowledge, skill, judgment, and physical ability (if specified in the job classification) to do the job safely, and be certified to do so. The following paragraphs prescribe personnel certification requirements.

4.4.1 Exclusions.

4.4.1.1 This paragraph does not apply to personnel engaged in operations that already require skill certification by quality assurance organizations, such as soldering, brazing, crimping, potting, etc., or to personnel performing inspections using dye penetrant, magnetic particle, ultrasonic, radiograph, and magnaflux, etc.

4.4.1.2 Certification of equipment and facilities is not within the scope of this chapter but may be as important as personnel certification in relation to safety. Information concerning equipment and facilities certification for operational readiness is found in Chapters 6, 8, and 9.

4.4.1.3 This chapter shall not be used as a justification for allowing hazardous duty payments, environmental differential pay, or premium pay, nor will the fact that a job qualifies for hazardous duty pay imply that it is covered by this chapter. It has always been NASA safety policy to make all operations as safe as possible. Hazard duty pay differentials are covered in 5 CFR Part 532, "Prevailing Rate System," and 5 CFR Part 550, "Pay Administration."

4.4.2 Hazardous Operations Requiring Safety Certification.

Hazardous operation safety certification is required for those tasks that potentially have an immediate danger to the individual (death/injury to self) if not done correctly, or could create a danger to other individuals in the immediate area (death or injury), or are a danger to the environment. Detailed training and certification requirements may be found in specific NASA Standards, e.g., NASA-STD-8719.9, "NASA Safety Standard for Lifting Devices and Equipment," or NASA-STD-8719.12, "NASA Safety Standard for Explosives, Pyrotechnics, or Propellants." Center safety officials or their designees can require additional hazardous operation safety certifications but must include the following:

4.4.2.1 Flight crew members (FAA licensing may not be sufficient).

4.4.2.2 Firefighters.

4.4.2.3 Propellant or explosives users per NASA-STD-8719.12.

4.4.2.4 Propellant or explosives handlers.

4.4.2.5 Rescue personnel.

4.4.2.6 Self-contained breathing apparatus (SCBA) users.

4.4.2.7 Self-contained underwater breathing apparatus (SCUBA) users.

4.4.2.8 High-voltage electricians.

4.4.2.9 Altitude chamber operators.

4.4.2.10 High-pressure liquid/vapor/gas system operators.

4.4.2.11 Hyperbaric chamber operators.

4.4.2.12 Tank farm workers.

4.4.2.13 Wind tunnel operators.

4.4.2.14 Welders.

4.4.2.15 Laser operators/maintenance personnel.

4.4.2.16 Centrifuge operators.

4.4.2.17 Range safety officers.

4.4.2.18 Crane operators.

4.4.2.19 Riggers for hoisting operations.

4.4.2.20 Heavy equipment operators.

4.4.2.21 Confined space entry personnel.

4.4.2.22 Lockout/tagout personnel.

4.4.3 Hazardous Materials Handlers Certification.

This safety certification is required for those individuals involved strictly with the handling, transport, or packaging of hazardous materials that will not otherwise disturb the integrity of the basic properly-packaged shipping container that holds the hazardous material. Operations that involve the reduction of palletized or otherwise combined items of packaged hazardous materials qualify as handling.

4.4.4 Certification Requirements.

All personnel engaged in potentially hazardous operations or hazardous material handling, as determined by line management or Center safety officials, will be certified as capable to operate the equipment or perform their jobs in a safe manner. All contractor personnel engaged in potentially hazardous operations or hazardous material handling shall be certified via a similar process.

4.4.4.1 For hazardous operations certification, the following is required as a minimum:

a. Physical examination as required (see paragraph 4.4.4.3).

b. Initial training (classroom and/or on-the-job). The level and structure of training is established according to the hazards of the job being performed.

c. Written examination (as needed) to determine adequacy and retention of training.

d. Periodic refresher training needs as determined by the Center safety official, including review of emergency response procedures.

e. Recertification period (as determined by the Center safety official, but shall not exceed a 4-year interval).

4.4.4.2 For hazardous material handlers, the following is required as a minimum for certification:

a. Specific training in the Federal, NASA, and local rules for preparing, packaging, marking, and transporting hazardous material and/or equipment operation associated with the job. Drivers or operators of vehicles transporting hazardous materials shall be instructed in the specific hazards of the cargo or material in their vehicle and the standard emergency and first-aid procedures that should be followed in the event of a spill or exposure to the hazardous material. Training requirements can be found in Department of Labor (DOL) at 29 CFR Part 1910, "Occupational Safety and Health Standards," and Department of Transportation (DOT) regulations at 49 CFR Part 177, "Carriage by Public Highway." The risk of all hazardous chemicals produced or imported shall be evaluated. Information involving this risk must be available to all employees in accordance with 29 CFR 1910.1200, "Hazard Communication," and NHS/IH-1845.3, "Hazard Communication."

b. Written examination (as needed) to determine the adequacy and retention of the training.

c. The recertification period will be as determined by the Center safety officials in the absence of any local, State, or Federal requirements.

4.4.4.3 Unless otherwise specified, the need for physical examinations to support operator certification requirements will be as determined by the cognizant health official and will be in compliance with the applicable codes, regulations, and standards covering the occupation or environment. The need for fitness-for-duty examinations should be based on the hazardous consequences of employee`s inability to perform the job correctly due to physical or mental deficiencies.

4.4.4.4 Personnel who are hazardous-operations-safety-certified or hazardous-material-handler-certified will be identified through the issuance of a card, license, or badge (to be immediately available) or a listing on a personnel certification roster or database. The roster indicates name, date, materials or operations for which certification is valid, name of certifying official, and date of expiration.

4.5 Mission Critical Personnel Reliability Program (PRP)

This program is detailed in 14 CFR Part 1214. The director of each NASA installation will designate mission critical areas for the Space Shuttle and other critical systems including the International Space Station, designated Expendable Launch Vehicles, designated payloads, Shuttle Carrier Aircraft, and other designated resources that provide access to space. Personnel having unescorted access to these areas must meet the suitability, qualification, and screening provisions outlined in the CFR. Contracts which cover mission critical operations or areas will reference NFS 1852.246-70, "Mission Critical Space System Personnel Reliability Program."

CHAPTER 5. Nuclear Safety for Launching of Radioactive Materials

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5.1 Purpose

5.1.1 This chapter provides internal NASA procedural guidance for characterizing and reporting potential risks associated with a planned launch of radioactive materials into space, on launch vehicles and spacecraft, during normal or abnormal flight conditions. Procedures and levels of review and analysis required for nuclear launch safety approval vary with the quantity of radioactive material planned for use and the perceived and potential risk to the general public and the environment.

5.1.2 An analysis or evaluation may be required in accordance with paragraph 9 of Presidential Directive/National Security Council Memorandum Number 25 (PD/NSC-25), "Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space," dated December 14, 1977, as revised on May 8, 1996, in obtaining nuclear launch safety approval. Guidance on procedures, requirements, or licensing details for using, storing, shipping, or handling radioactive materials in ground processing facilities or activities or in preparation for space uses is not included in this chapter. (See paragraph 6.1.10.) The tracking of radiation exposures to workers is also not included in this chapter.

5.1.3 NASA missions involving the launch of radioactive materials must also comply with the provisions of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), following the policy and procedures contained in 14 CFR Subpart 1216.3, "Procedures for Implementing the National Environmental Policy Act (NEPA)," NPG 8840.x, "NASA Procedures and Guidelines for Implementating the National Environmental Policy Act, and Executive Order 12114."

5.2 Guideline Overview

5.2.1 Compliance with space nuclear launch safety processes is the responsibility of senior NASA officials involved with the control and processing of radioactive materials for launch into space. Acceptability of the potential risk of launching and use of nuclear materials in space is determined by the NASA Administrator or designee, as appropriate.

5.2.2 Basic designs of vehicles, spacecraft, and systems utilizing radioactive materials should provide protection to the public, the environment, and users such that radiation doses resulting from exposures to the radiation sources are as low as reasonably achievable (ALARA). Nuclear safety considerations shall be incorporated from the initial design stages throughout all project stages to ensure the overall mission radiological health risk is acceptable.

5.2.3 All space flight equipment (including medical and other experimental uses) that contain or use radioactive materials shall be identified and analyzed (per paragraph 5.4) to identify the degree of introduced radiological risk.

5.2.4 NASA shall develop or ensure development of site-specific ground operations and radiological contingency plans commensurate with the risk represented by the planned launch of nuclear materials. Contingency planning, as required by the Federal Radiological Emergency Response Plan, will include provisions for emergency response, including support for source recovery efforts. NPD 8710.1, "NASA Emergency Preparedness Program Policy," and NPG 8715.x, "NASA Emergency Preparedness Program Plan Procedures and Guidelines," address the NASA emergency preparedness policy and program requirements.

5.2.5 NASA shall apply the range safety requirements, with regard to safe launching of radioactive materials, specified in range safety standards.

5.3 Responsibilities

5.3.1 The Office of Safety and Mission Assurance (OSMA) shall do the following:

5.3.1.1 Ensure that launches of radioactive materials are approved in accordance with paragraph 9 of PD/NSC-25, as applicable.

5.3.1.2 Assist in the reviews or evaluations of nuclear safety.

5.3.1.3 Ensure appropriate coordination with the Federal Emergency Management Agency to provide adequate emergency and recovery planning for all NASA missions with a threshold of 1,000 for A_2 mission multiple as defined in paragraph 5.4.2.

5.3.1.4 Ensure that radiological emergency and recovery plans are developed and ensure their implementation where NASA is the Lead Federal Agency as defined by the Federal Radiological Emergency Response Plan.

5.3.1.5 Prepare, coordinate, and provide the required notification of planned launches of radioactive materials to the Executive Office of the President, Office of Science and Technology Policy (OSTP).

5.3.1.6 Designate a Nuclear Flight Safety Assurance Manager (NFSAM), and, after a request by the program or mission office, designate a NASA coordinator to support each empanelled ad hoc Interagency Nuclear Safety Review Panel (INSRP); and provide for the support to assist the program/project offices in meeting the required nuclear launch safety analysis/evaluation. Appointment of the NFSAM and INSRP coordinator(s) requires the concurrence of the affected Strategic Enterprise (s). In appropriate circumstances, the NFSAM and NASA INSRP coordinator(s) may be separate individuals.

5.3.2 Enterprise/program/project offices shall do the following:

5.3.2.1 Designate an individual responsible for ensuring the implementation of the requirements for nuclear launch safety approval in accordance with paragraph 9 of PD/NSC-25.

5.3.2.2 Confer with the NASA Headquarters NFSAM as soon as radioactive sources are identified for potential use on NASA spacecraft to schedule the nuclear launch safety approval activities.

5.3.2.3 Identify the amount of radioactive material and applicable process for documenting the risk represented by the use of radioactive materials planned for use on the launch in accordance with paragraph 5.4 and provide required reports in accordance with paragraph 5.5.

5.3.2.4 Prepare or have prepared the nuclear safety analyses and obtain nuclear launch safety approval or launch concurrence or approval in accordance with paragraph 5.4 as required.

5.3.3 NASA Centers, facilities, and laboratories shall do the following:

5.3.3.1 Ensure, to the extent of responsibility applicable under defined licensing/permitting documentation or agreements, compliance with all pertinent directives, licenses, agreements, and requirements promulgated by appropriate regulatory agencies relative to the use of radioactive materials planned for a space launch.

5.3.3.2 Coordinate with appropriate program/project office(s) to ensure radioactive source reports that are submitted per paragraph 5.5.2 accurately reflect all known radioactive sources under the control of that Center which are intended for flight.

5.3.4 NASA launch and landing sites, in addition to the responsibilities of NASA Centers, facilities, and laboratories as per paragraph 5.3.3, shall perform the following:

5.3.4.1 For planned launches or landings of radioactive sources from the United States or its territories or possessions, as appropriate:

a. Develop and implement site-specific ground operations and radiological contingency plans to address potential ground handling accidents and potential launch/landing accident scenarios, and to support source recovery operations commensurate with the radioactive materials present.

b. Exercise contingency response capabilities as deemed necessary to ensure adequate readiness of participants and adequacy of planning to protect the public, site personnel, and facilities.

c. Ensure appropriate and timely coordination with regional Federal, State, territorial, and local emergency management authorities to provide for support to and coordination with offsite emergency response elements.

d. Make provisions for special offsite monitoring and assistance in recovery if radioactive materials could spread into areas outside the geographical boundaries of the launch site.

5.3.4.2 Establish a radiological control center (RADCC) for launches and landings with radioactive sources possessing a significant health or environmental risk, or having an activity of A_2 mission multiple greater than 1,000 as determined per paragraph 5.4.2, or as specified in applicable interagency agreements. The RADCC will provide technical support and coordination with other Federal/State/territorial/local agencies in the case of a launch or landing accident that may result in the release of radioactive materials. The RADCC shall be staffed commensurate with the risk associated with the radioactive materials present. The RADCC shall be operational during launch and landing phases anytime there is a potential for an accident that could release radioactive material.

5.3.5 The NASA INSRP coordinator for an empanelled INSRP shall do the following:

5.3.5.1 Coordinate NASA's participation in activities required for the generation of the Safety Evaluation Report (SER) including coordination with program/project personnel to ensure adequate information is available to the INSRP.

5.3.5.2 Make arrangements for NASA employees to provide technical assistance to the INSRP. Coordinate the support needs of those selected to provide this assistance with NASA Headquarters Offices and through the NASA Center, Facility, and Laboratory Directors as may be appropriate (i.e.; travel, funding, technical).

5.4 The Nuclear Launch Safety Approval Process

5.4.1 The level of analysis, evaluation, review, and concurrence or approval required for radiological risk assessment varies with the total activity of radioactive materials planned for launch as follows:

5.4.1.1 For all planned launches of radioactive materials, the A_2 mission multiple value shall be used to determine the level of assessment required.

5.4.1.2 The NASA office responsible for the mission shall inform the NFSAM as soon as radioactive material is identified for potential use. Notification shall consist of the information contained in the report format described in paragraph 5.5.2. This notification is required for NASA payload launches, on NASA launch vehicles, and when NASA facilities or sites are used.

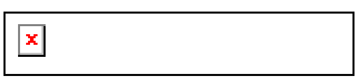
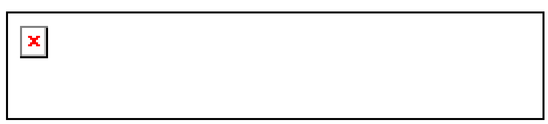
5.4.1.3 If NASA participates in the launch of a vehicle or spacecraft from other countries or territories, and these vehicles or spacecraft contain a radioactive source, the program/project office shall consult with the NFSAM and the NASA Office of the General Counsel to determine what provisions, if any, of this chapter apply.

5.4.1.4 The total mission radioactive material activity shall be determined for all radioactive materials contained on the launch to calculate the total A_2 mission multiple per paragraph 5.4.2. The A_2 mission multiple shall be the highest of the algebraic sum of the isotopes' A_2 multiples at launch, anytime the spacecraft will be in earth orbit, or during near earth interplanetary flight (e.g., Earth Gravity Assists).

5.4.2 Determination of A_2 Mission Multiple.

The A_2 multiplier for each radioactive source shall be based upon the International Atomic Energy Agency (IAEA), Safety Series Number 6, Regulations for the Safe Transport of Radioactive Material, 1985 Edition as amended in 1990, Section III, paragraphs 301 through 306, and then summed to determine the A_2 mission multiple. Table I of Appendix G of this NPG contains the referenced IAEA document section which tabulates the A_2 values for specific isotopes and forms of radioactive material. Except as noted, for radioisotopes whose A_2 limit in Table I is "Unlimited" or is unlisted, the value of 3.7×10^{-2} teraBecquerals (TBq) (1.0 Curies (Ci)) shall be used as the A_2 value. Exceptions are Sm-147 which shall use 9×10^{-4} TBq (0.024 Ci) and Th-232 which shall use 9×10^{-5} TBq (0.0024 Ci) as their respective A_2 values.

The A_2 mission multiple shall be determined as follows:

where n represents each source or line on the reports in paragraph 5.5.2 for each radioactive material on the launch vehicle and spacecraft.

5.4.3 Paragraphs 5.4.4 through 5.4.7 describe the internal NASA nuclear launch safety process. Table 5.1 provides a summary of the reviews.

A_2 Mission Multiple	Launch Reported to NFSAM	Launch Concurrence/ Approval by	Launch Reported to OSTP	Required Level of Review and Reports	Approval/ Concurrence
$A_2 < 0.001$	Yes	NFSAM	no	Paragraph 5.5.2 Report	Concurrence letter from NFSAM

$0.001 \leq A_2 < 10$	Yes	NFSAM	yes	Paragraph 5.5.2 Report	Concurrence letter from NFSAM
$10 \leq A_2 < 500$	Yes	AA/OSMA	yes	Paragraph 5.5.2 Report, Nuclear Safety Review	Concurrence letter from AA/OSMA
$500 \leq A_2 < 1{,}000$	Yes	NASA Administrator	yes	Paragraphs 5.5.1, Safety Analysis Summary, and 5.5.2, Report	Approval letter from NASA Administrator
$1000 \leq A_2$	Yes	Executive Office of the President	yes	Paragraphs 5.5.1, Safety Analysis Summary, and 5.5.2, Report	NASA Administrator requests approval via Director OSTP

Table 5.1. Nuclear Launch Safety Approval Summary

5.4.4 For launches with A_2 mission multiples of less than 0.001 (in addition to requirements in paragraph 5.4.1), the program manager shall request nuclear launch safety concurrence in writing. The request should be submitted to the NFSAM a minimum of 4 months prior to launch. The request should be accompanied by the Radioactive Materials Report required by paragraphs 5.4.1.1 and 5.5.2. The NFSAM will review the report and will inform the program manager in writing of concurrence/non-concurrence and any safety concerns not less than 2 months prior to launch.

5.4.5 For launches with A_2 mission multiples of between 0.001 and 10 (in addition to the requirements in paragraph 5.4.1), the program manager shall request nuclear launch safety concurrence in writing. The request should be submitted to the NFSAM a minimum of 4 months prior to launch. The request should be accompanied by the Radioactive Materials Report required by paragraph 5.4.1.1 and 5.5.2. The NFSAM will review the request and will inform the program manager in writing of nuclear launch safety concurrence/non-concurrence (with any safety concerns) not less than 2 months prior to launch. Launches of these quantities of radioactive materials are reported quarterly to OSTP by the NFSAM.

5.4.6 For launches with $A_{2,}$ mission multiples of equal to or greater than 10 but less than 500 (in addition to the requirements contained in paragraph 5.4.1), the following apply:

5.4.6.1 Notification that a planned launch may contain radioactive materials in this range shall be made to the NFSAM and shall consist of the information contained in the Radioactive Materials Report required by paragraph 5.5.2, as a minimum. The report should be made as soon as the program identifies radioactive materials for potential use.

5.4.6.2 The NFSAM, in consultation with the program manager, shall make a preliminary scoping of the radiological risk to identify the extent of analyses needed as part of a pre-launch nuclear safety review. The NFSAM and the program manager shall determine a mutually agreed schedule for developing a nuclear safety review.

5.4.6.3 The program manager shall prepare or have prepared a nuclear safety review of the radiological risk of the proposed mission. The review shall contain, as a minimum, the following:

a. The report described in paragraph 5.5.2.

b. Program excerpts describing the mission.

c. Probability of launch and in-flight accidents which could result in release of radioactive materials on the Earth.

d. Reasonable upper bound of health and environmental effects due to a radioactive material release.

e. Mission-specific information recommended for consideration in the launch or potential accident site emergency response and clean-up planning.

5.4.6.4 The nuclear safety review shall be provide to the AA/OSMA along with a request for nuclear safety launch concurrence. The request should be made approximately 5 months prior to launch.

5.4.6.5 The NFSAM shall notify OSTP of the planned launch as a part of the quarterly report of planned launches.

5.4.7 For launches with A_2 mission multiples of equal to or greater than 500 but less than 1,000 (in addition to the requirements contained in paragraph 5.4.1), the following apply:

5.4.7.1 Notification that a planned launch may contain radiological materials in this range shall be made to the NFSAM and shall consist of the information contained in the Radioactive Sources Report required by paragraph 5.5.2 as a minimum. The report should be made as soon as the program identifies radioactive materials for potential use.

5.4.7.2 The NFSAM shall make a preliminary assessment of the radiological risk and provide a written assessment to the program manager. The NFSAM and the program manager shall determine a mutually agreed to schedule for nuclear launch safety analyses and review activities to be conducted to support a nuclear launch safety concurrence request.

5.4.7.3 The program manager shall prepare or have prepared a Safety Analysis Summary (SAS) that, in coordination with the NFSAM, addresses the radiological risk of the proposed mission. The level of detail in the SAS will be commensurate with the radiological risk. The program is encouraged to use other program documentation to provide mission and potential accident information in the SAS. As a minimum, the SAS shall contain the following:

a. Brief descriptions of the planned mission, schedule, launch vehicle, and spacecraft to include operations while in-orbit and during near-earth flight.

b. Description of all radioactive materials, their physical state/chemical form, and quantities.

c. Brief descriptions, probabilities, and resulting consequences of launch and in-flight accidents that could result in release of radiological materials on the Earth.

d. Estimate of any health and environmental effects due to a radioactive material release.

e. Mission specific information recommended for consideration in the launch or potential accident site emergency response and clean-up planning.

5.4.7.4 The NFSAM shall review the SAS and provide timely comments to the program, in accordance with the mutually agreed schedule. Approximately 5 months before launch, the SAS shall be forwarded to the NASA Administrator by the program, with concurrence of the AA/OSMA, with a request for nuclear launch safety approval from the NASA Administrator.

5.4.7.5 The NFSAM shall notify OSTP of the planned launch as a part of the quarterly report of planned launches.

5.4.8 For launches with A_2 mission multiples equal to or greater than 1000 (in addition to requirements in paragraph 5.4.1), the following apply:

5.4.8.1 Notification that a planned launch may contain radioactive materials in this range shall be made to the NFSAM and shall consist of the information contained in the Radioactive Sources Report required by paragraph 5.5.2 as a minimum. The report should be made as soon as the program identifies radioactive materials for potential use.

5.4.8.2 The program manager, in coordination with the OSMA, shall request the NASA Administrator empanel an ad hoc INSRP for that mission. INSRP empanelling should occur soon after the program identifies radioactive materials for potential use. The time required for an INSRP can be lengthy and must be factored into the program master schedule. The membership and responsibilities of the empanelled INSRP shall be in accordance with PD/NSC-25.

5.4.8.3 The program manager shall prepare or have prepared a Safety Analysis Report (SAR). The level of detail and content of the SAR will be commensurate with the mission radiological risk. In cases where DOE provides the radioactive material, the DOE programmatic SAR may be adopted to satisfy this requirement, in accordance with the interagency agreement(s) for specific missions. In cases where launch vehicles, configuration, and radioactive materials are similar, the program manager, in consultation with the NFSAM and the INSRP, is encouraged to use a comparative analysis based upon previous mission(s) safety analyses that bound the anticipated risk for the new mission. Where radioactive materials are being provided from multiple sources, the program manager may provide a single or multiple SAR/SAS document(s) to best meet this requirement.

5.4.8.4 The program manager is encouraged to begin coordination with the empanelled ad hoc INSRP in the early stages of mission development. The program manager should invite the INSRP to review the development of launch and mission accident scenarios, probabilities of occurrence, dispersion, specification of associated environments, and health effects via documentation and program safety reviews. The INSRP normally reviews and evaluates all program documentation associated with the radioactive material safety for completeness and defensibility. The INSRP evaluation is documented in a Safety Evaluation Report (SER). The INSRP is normally assisted in its evaluation effort by expert consultants in various specialized areas from a number of Government agencies, national laboratories, industry, and academia.

5.4.8.5 The SAR shall be delivered to the INSRP according to a schedule mutually agreed upon by the INSRP and the program manager with the understanding that a SER should be completed at least 4 months before launch. The mutually agreed upon schedule should address the planned analysis schedule, base assumptions, analysis limitations/bounds, and model descriptions associated with the SAR development. Interim reviews should be held to review all individual analyses before completion and provide evaluation status of analyses as of a given date.

5.4.8.6 The INSRP prepares a SER of the radiological risk analyzed in the SAR. The SER, along with the SAR and other related documents, are considered by the NASA Administrator before requesting nuclear launch safety approval in accordance with PD/NSC-25.

5.4.9 For any orbiting spacecraft being resupplied or modified in which the U.S. Government is the lead (e.g.; International Space Station), a nuclear launch safety approval for a mission is required when the total onboard A_2 mission multiple will exceed 10 for the orbiting spacecraft. Safety analyses and reviews shall be performed to the level of detail and launch concurrence/approval requirements defined in paragraph 5.4.7 for in-flight accidents. An INSRP shall only be required when the A_2 mission multiple will exceed 1,000 per paragraph 5.4.8.

5.5 Report Requirements

5.5.1 Nuclear launch safety analyses (e.g., SAS, SAR) and evaluation (e.g., SER) are described in the previous paragraphs.

5.5.2 Radioactive Materials Report

The Radioactive Materials Report shall be used by NASA program/project offices and NASA Centers/facilities/laboratories to report planned launches of radioactive materials and request for nuclear launch concurrence/approval. The NFSAM shall use this report format for the quarterly report used to notify OSTP of planned launches. Figures 5.1 and 5.2 show the format for the reports for planned launch and for resupplying radioactive materials to on-orbit spacecraft. Entries shall be made for each isotope source. Isotopes of similar size, chemical form, and activity level may be combined on a single line entry.

Vehicle/ Spacecraft	Planned Launch Date	Launch Site	Number of Sources	Isotope	Total Activity (Ci)	A_2 Limit for Isotope (Ci)	A_2 Multiple for Each Isotope Source	Remarks
	(Use one line for each isotope type, size, and form)							
	(Use one line to sum the A_2 mission multiples for each mission)							

Figure 5.1. Planned Launches of Radioactive Materials Report

Figure 5.2 shows the format for the report for orbiting spacecraft which are resupplied (e.g., Space Station).

Isotope	Date Arrived On-Board	Number of Sources	Total Activity at Arrival (Ci)	IsotopeHalf-life	Activity as of Mission Start (Ci)	A_2 Limit for Isotope (Ci)	Current A_2 Multiple for Each Isotope Source	Remarks
	(Use one line for each isotope type, size, form, and arrival date)							
	(Use one line to sum the A_2 mission multiples for the spacecraft)							

Figure 5.2. Radioactive Materials On-Board Report

The Activity and Fissile Material Limits table is located in Appendix G.

CHAPTER 6. Operational Safety

6.1 Purpose

This chapter establishes safety procedures for NASA's operational safety program.

6.2 Objectives

The objective of this chapter is to protect the public; flight, ground, laboratory, and underwater personnel; the environment; aircraft; spacecraft; payloads; and property from operations-related safety hazards. This is not inclusive of all regulations and requirements governing operations. References are indicated liberally throughout the text for detailed or working standards, specifications, and other references.

6.3 Motor Vehicle Safety

Each Center shall adopt procedures that comply with applicable Federal, State, and local motor vehicle safety regulations.

6.3.1 Motor Vehicle Operation.

6.3.1.1 Operators of motor vehicles shall not drive a motor vehicle for a continuous period of more than 10 hours, including non-NASA driving; nor shall the combined duty period exceed 12 hours in any 24-hour period, without at least 8 consecutive hours of rest. Variation in the above policy requires documented Center safety office approval.

6.3.1.2 If operation of the vehicle involves skills beyond those associated with normal, everyday operation of private motor vehicles, formal initial training, consisting of both classroom and operational testing, shall be conducted to ensure operator proficiency. Refresher training and testing shall be accomplished periodically as determined by the Center safety office.

6.3.1.3 All NASA motor vehicles used off NASA Centers shall be inspected to the standards of the State or other jurisdiction's vehicle safety inspection requirements.

6.3.2 Seat Belts.

6.3.2.1 Federal employees will use seat belts while on official business as required in Section 1 of

Executive Order (EO) 13043 of April 16, 1997, "Increasing Seat Belt Use in the United States." The EO states seat belt use is required by Federal employees operating or in any vehicle with seat belts while on Federal business. All NASA employees shall comply with this mandatory requirement while traveling on official business.

6.3.2.2 Children unable to use the seat belts will be secured in DOT-approved child safety seats.

6.3.2.3 Passengers are forbidden to be carried in the cargo area of pickup trucks, flatbeds, or special purpose equipment such as fire trucks or escape trucks unless designated occupant positions are provided (see 49 CFR Part 571) and required seat belts are provided.

6.3.2.4 All occupants of motor vehicles (so equipped) operated on NASA property, including delivery vans and trucks of all sizes, will have their seat belt properly fastened around themselves at all times the vehicle is in motion.

6.3.3 Annual Seat Belt Report.

6.3.3.1 NASA is required by EO 13043 to prepare an annual status report to the Secretary of Transportation on NASAwide seat belt use. The report includes seat belt usage rates and statistics of crashes, injuries, and related costs involving Federal employees on official business. The Safety and Risk Management Division is responsible for the preparation and submittal of the report to DOT. DOT consolidates this data into an annual status report to the President for all Federal Agencies.

6.3.3.2 The Safety and Risk Management Division will coordinate data for the annual report with the Office of Management Systems and the Office of Life and Microgravity Sciences and Applications. The format and submittal date for the report will be as directed each year by the Secretary of Transportation.

6.3.4 Traffic Control Devices and Markings.

American National Standard Institute (ANSI) D6.1, "Manual on Uniform Traffic Control Devices for Streets and Highways," shall be used for guidance when setting traffic control devices or marking roads for motor vehicle operations on NASA property.

6.4 Personal Protective Equipment

6.4.1 General

Personal protective equipment (PPE) shall be issued to NASA employees at Government expense in those situations where engineering controls, management controls, or other corrective actions have not reduced the hazard to an acceptable level or where use of engineering controls, management controls, or other techniques is not feasible.

6.4.2 Procurement.

6.4.2.1 Center Directors and the Associate Administrator for Headquarters Operations are authorized to purchase PPE after the purchase request has been reviewed by safety and health professionals to determine proper specifications and adequacy of abatement. It is recommended that local safety and health committees be involved in the decision.

6.4.2.2 The authority for the purchase of PPE with appropriated funds is 5 U.S.C. 7903, "Protective

Clothing and Equipment."

6.4.2.3 Only clothing and equipment meeting Federal regulations, industrial standards, or NASA special testing requirements shall be used.

6.4.3 Issuance

6.4.3.1 PPE shall be issued to all NASA employees exposed to hazards in accordance with paragraph 6.5.1. Accountability shall be in accordance with NPG 4200.1, "NASA Equipment Management Manual." Transients or visitors may be furnished PPE on a temporary basis if they are on site for NASA-related business purposes or at NASA's invitation. The host, guide, or area supervisor shall be responsible for obtaining, issuing, and recovering the PPE. Other non-NASA, contractor, and non-contractor personnel must procure their own PPE to provide an equivalent level of safety as required by NASA. (See paragraph 2.4.3.)

6.4.3.2 PPE shall be provided, used, stored, and maintained, and employees trained in its use, in accordance with 29 CFR 1910.132 through 1910.137. NASA PPE will be stocked and issued as specifically directed in NPG 4100.1, "NASA Materials Inventory Management Manual."

6.4.4 Examples of PPE. Items which may be purchased and issued by NASA include, but are not limited to, the following:

6.4.4.1 Safety goggles and safety spectacles (plain and prescription).

6.4.4.2 Welding helmets and shields.

6.4.4.3 Safety shoes.

6.4.4.4 Steel sole and/or toe safety boots.

6.4.4.5 Aprons, suits, and gloves (e.g., fire resistant materials, leather, rubber, cotton, and synthetics).

6.4.4.6 Protective head gear (e.g., hard hats and caps, liners, helmets, and hoods).

6.4.4.7 Face shields.

6.4.4.8 Specialty items of protective nature (e.g., cryogenic handlers suits, SCAPE suits, fire fighter suits, foul weather gear, harnesses, life belts, lifelines, life nets, insulated clothing for "cold test" exposure, supplied air suits, and electrical protective devices).

6.4.4.9 Concentration alarms, toxic gas indicators, explosive gas indicators.

6.4.5 Health-related PPE. If respirators are used, Centers are required to have a formal Respiratory Protection Program. The Office of Health Affairs at NASA Headquarters provides guidance for purchasing, training, selection, and qualification for use of respiratory protective devices and other health-related PPE.

6.5 Control of Hazardous Energy (Lockout/Tagout Program)

NASA will meet or exceed OSHA minimum performance requirements for the control of hazardous energy as outlined in 29 CFR 1910.147. All NASA Centers shall establish a program for controlling hazardous energy during service and maintenance operations where the unexpected energizing or startup of equipment could cause injury to employees or equipment damage. The Center programs shall comply with all aspects of 29 CFR 1910.147 for electrical, pressure, hydraulic, pneumatic, and mechanical systems as a minimum.

6.6 Pressure and Vacuum Systems Safety

NASA's program for ensuring the structural integrity of pressure vessels and pressurized systems (PV/S) and minimizing the associated mishap potential is outlined in NPD 8710.5, "NASA Policy for Pressure Vessels and Pressurized Systems." This NPD assigns responsibilities for the various aspects of the program; references the codes, standards, guides, and Federal regulations that must be followed; and establishes unique NASA requirements in areas such as certification/recertification, documentation, configuration management, and operator training/certification. The NPD also addresses flight systems qualification and acceptance.

6.7 Electrical Safety

This paragraph provides directives for protecting persons and property from electrical hazards. It applies to all NASA uses of electrical power.

6.7.1 Hazards.

Electrical systems shall be designed in accordance with the National Electric Code, MIL-STD 454, "Standard General Requirements for Electronic Equipment," or Center-specific requirements if more specific. Electrical systems shall be operated and maintained to adequately control hazards that are likely to cause death or serious physical harm or severe system damage. All electrical systems shall be reviewed by the Center's safety office for appropriate location and for proximity of ignitable or combustible material such as gas, vapor, dust, or fiber.

6.7.2 Requirements.

6.7.2.1 All electrical work deemed hazardous by job safety analysis shall be performed by personnel familiar with electrical code requirements and qualified/certified for the class of work. All persons engaged in electrical work shall be instructed in accident prevention and fully informed of the hazards involved. They shall be trained in first-aid procedures that include cardiopulmonary resuscitation.

6.7.2.2 Supervisors shall ensure that no person works alone with high voltage electricity. One person, trained to recognize the electrical hazards, shall be delegated to watch the movements of the other working personnel to warn them if they get dangerously close to live conductors or perform unsafe acts and to assist in the event of an accident.

6.7.2.3 Transformer banks or high-voltage equipment (500+ volts) shall be protected by an enclosure to prevent unauthorized access. Metallic enclosures shall be grounded. Entrances not under constant observation shall be kept locked. Signs warning of high voltage and prohibiting unauthorized entrance shall be posted at entrances and on the perimeter of the enclosure. An authorized access list of qualified personnel shall be maintained.

6.7.2.4 Where electrostatic discharge (ESD) is a significant hazard to personnel or hardware, conductive floors or other methods will be used.

6.8 Hazardous Material Transportation, Storage, and Use

This paragraph provides direction for protecting persons and property during the transportation, storage, and use of hazardous materials. Every effort shall be made to ensure complete safety and compliance with applicable Federal, State, and local laws and regulations. Hazardous material is defined by law as "a substance or materials in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce" (49 CFR 171.8). The Secretary of Transportation has developed a list of hazardous materials that is found in 49 CFR 172.101. At a minimum, the Federal regulations (e.g., DOT, EPA, OSHA) for transport of hazardous materials on both Federal property and public roadways shall be met. Typical hazardous materials are those that may be highly reactive, poisonous, explosive, flammable, combustible, corrosive, radioactive; produce contamination or pollution of the environment; or cause adverse health effects or unsafe conditions. For more detailed requirements, see NHS/IH-1845.3, "Hazard Communication," and NHS/IH-1845.5, "Occupational Exposure to Hazardous Chemicals in Laboratories."

6.8.1 Transporting Hazardous Material.

6.8.1.1 NASA policy for transporting hazardous material or hazardous or radiological waste is contained in NPD 6000.1, "Transportation Management."

6.8.1.2 All contractor motor vehicles, rail cars, boats, and ships covered by NASA Bill of Lading and used for transportation of hazardous material shall comply with laws regarding inspections and markings and must have passed an inspection prior to loading to ensure that the vehicle or vessel is in safe mechanical condition. The mode of transportation shall be inspected to the applicable standards of the Federal Highway Administration, U.S. Coast Guard, Department of Transportation, and Federal Railroad Administration. All vehicles transporting hazardous materials on NASA and public roadways shall display all DOT-required placards, lettering, or numbering.

6.8.1.3 Hazardous material as defined in DOT's "Hazardous Material Regulations" at 49 CFR 171.8 shall not be transported in NASA administrative aircraft. To ensure hazardous material is not inadvertently loaded on administrative aircraft, all cargo for shipment should be routed through the Center's transportation office or, if enroute, cargo should be accepted only from a certified shipper or freight forwarding agency.

6.8.2 Storage, Use, and Disposal.

Storage, use, and disposal should comply with Federal and State regulations and address the requirements for release prevention, control, countermeasures, contingency planning, and a listing of restricted/prohibited materials for purchasing and use at Centers. Inventories shall be conducted at least annually and conditions of materials in storage assessed at least monthly, and those determined to be unsuitable for use removed from active inventory.

6.8.3 Material Safety Data Sheets (MSDS).

NASA procurement activities require the referencing of 29 CFR 1910.1200 and Federal Standard 313, "Federal Standard for Preparation and Submission of Material Safety Data Sheets," as revised, in commodity specifications, purchase descriptions, purchase orders, contracts, and other purchase documents. The receiving office at each Center shall provide copies of the MSDS for receipt of such commodities to the central office responsible for maintaining the MSDS records. Magnetic disk or paper copies of all MSDS will be maintained in the work area where the material is being used or stored. See

NHS/IH-1845.3, "Hazard Communication." The NASA MSDS Inventory is accessible at: http://msds.ksc.nasa.gov.

6.9 Hazardous Operations

NASA hazardous operations involve materials or equipment that, if misused or mishandled, have a high potential to result in loss of life, serious injury to personnel, or damage to systems, equipment, or facilities. Adequate preparation and strict adherence to operating procedures can prevent most of these mishaps. Each Center/program will provide the following actions for hazardous operations.

6.9.1 Hazardous Operating Procedure.

6.9.1.1 Each Center shall identify hazardous operations and identify, assess, analyze, and develop adequate safety controls. Generally, all hazardous operations shall require Hazardous Operating Procedures or a Hazardous Operating Permit (HOP). HOP's consist of a detailed plan listing step-by-step functions or tasks to be performed on a system or equipment to ensure safe and efficient operations. HOP's list special precautions, start and stop time of the operation, and the approving supervisor(s). Certain operations (e.g., rigging, high voltage, etc.) depend on adherence to overall standards and general guidelines and specific training as opposed to HOP's for each specific operation. In these cases, specific personnel certification requirements must be established as listed in Chapter 4. Personnel other than the certified operators shall be excluded from exposure to the operation. Where the risk of injury is high, personnel shall use the buddy system whereby an adjacent or nearby person not directly exposed to the hazard serves as an observer to render assistance.

6.9.1.2 Hazardous procedures shall be marked conspicuously on the title page, e.g., THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS, to alert operators that strict adherence to the procedural steps and safety and health precautions contained therein is required to ensure the safety and health of personnel and equipment.

6.9.1.3 All HOP's developed at NASA sites or for NASA operations shall have a concurrence from the responsible development official and an approval signature to certify that a review has been performed by the cognizant NASA or contractor safety representative as applicable. Deviations or changes to HOP's also require the approval of the cognizant NASA or contractor safety office. If approved by the contractor, a copy should be forwarded to the appropriate local NASA safety office for informational purposes.

6.9.2 Personnel Certification.

Personnel who certify individuals to perform or control hazardous operations, or to use or transport hazardous material, must ensure the individuals possess the necessary knowledge, skill, judgment, and physical ability to do the job in a safe and healthful manner. See Chapter 4 for Hazardous Operations Safety Certification.

6.10 Laboratory Hazards

This paragraph provides guidance for protecting persons and property in a laboratory environment. For the purposes of this document, a laboratory is a facility in which experimentation, testing, and analysis are performed on human subjects, organisms, biological and other physical materials, substances, and equipment (including bioinstrumentation). Included also are certain equipment, repair, and calibration operations, and processing of materials.

6.10.1 Design Requirements.

6.10.1.1 Design of laboratories will incorporate the requirements of the applicable State and Federal codes required for the individual Center, e.g., building, electrical, fire protection for laboratory facilities. Escape routes shall be provided, designed, and marked in accordance with the National Fire Protection Association (NFPA) 101, "Life Safety Code." Occupational safety and health considerations such as ventilation, shower stalls, and eye wash stations shall be included in the design where applicable. For facility acquisition and construction safety guidance, see Chapter 8.

6.10.1.2 Areas with significant quantities of flammable, combustible, corrosive, and toxic liquids, solids, or gases shall be protected in accordance with the applicable provisions of NFPA 45, "Fire Protection for Laboratories Using Chemicals," as modified below. Laboratories not using or fitting the above chemical classification, yet housing unique, mission-critical, or high-value research equipment, shall conform to the provisions of NASA-STD 8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection."

6.10.1.3 Special facilities to ensure the integrity of both terrestrial environments and biological samples returned from space should be considered in the design of the laboratory if applicable.

6.10.1.4 Additional considerations shall be the biohazards resulting from use or handling of biological materials such as infectious microorganisms, viruses, medical waste, or genetically engineered organisms. See OSHA Standard 29 CFR 1910.1030, "Bloodborne Pathogens," for additional details.

6.10.2 Chemical and Hazardous Materials.

In addition to pertinent safety requirements found elsewhere in this document, the following requirements are specifically applicable to laboratories.

6.10.2.1 Laboratories meeting the definition as described in 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," shall be operated in accordance with chemical hygiene plans as stated in NHS/IH-1845.3, "Hazard Communications," and NHS/IH-1845.5, "Occupational Exposure to Hazardous Chemicals in Laboratories."

6.10.2.2 Suitable facilities for quick drenching or flushing of the eyes and body of any person exposed to injurious corrosive materials shall be provided within the work area for immediate emergency use. Body flushing of persons exposed to cryogenic liquids is not recommended by medical officials. Access to these facilities must be kept clear. Eyewashes and/or safety showers shall be located within reasonable travel distance for emergency use, depending on circumstances and configuration, but generally no more than 75 feet from the hazard source.

6.10.3 Solar Simulators.

All personnel shall wear skin and eye protection while in direct view of a bare pressurized arc lamp, whether energized or not, unless the system is locked out or tagged out for maintenance or repair.

6.10.4 Ventilation.

Assuring proper ventilation is a responsibility assigned to the occupational health program. See NPD 1800.2, "NASA Occupational Health Program."

6.10.5 Glassware.

Because some laboratory operations use a considerable amount of glassware and ceramics, necessary safeguards shall be employed to minimize personnel injury. Refer to the "Guide for Safety in the Chemical Laboratory," Manufacturing Chemists' Association, Inc., and "Handling Glassware."

6.11 Lifting Safety

NASA shall use the standards in NASA-STD-8719.9 (formerly NSS/GO 1740.9), "NASA Lifting Devices and Equipment Manual," for protecting persons and property during lifting operations. The standard establishes minimum safety requirements for the design, testing, inspection, personnel certification, maintenance, and use of overhead and gantry cranes, mobile cranes, derricks, hoists, special hoist-supported personnel lifting devices, Hydrasets, hooks, and slings for NASA-owned and NASA contractor-supplied equipment used in support of NASA operations at NASA Centers.

6.12 Explosive, Propellant, and Pyrotechnic Safety

NASA shall use NASA-STD-8719.12 (formerly NSS-1740.12), "NASA Safety Standard for Explosives, Propellants, and Pyrotechnics," for protecting persons and property from hazards of explosives and explosive materials, including all types of explosives, propellants (liquid and solid), oxidizers, and pyrotechnics. NASA-STD-8719.15 (formerly NSS 1740.15), "Safety Standard for Oxygen and Oxygen Systems," and NASA-STD-8719.16 (formerly NSS 1740.16), "Safety Standard for Hydrogen and Hydrogen Systems," address the requirements for working with those substances. Explosive, propellant, and pyrotechnic operations shall be conducted in a manner that exposes the minimum number of people to the smallest quantity of explosives for the shortest period consistent with the operation being conducted. An Authority Having Jurisdiction (AHJ) for Explosives, Propellant, and Pyrotechnic operations will be designated in writing by the Center Director. For specific responsibilities of the AHJ, refer to NASA-STD-8719.12 (formerly NSS 1740.12), "NASA Safety Standard for Explosives, Propellants, and Pyrotechnics."

6.13 Underwater Operations Safety

NASA-STD-8719.10 (formerly NSS 1740.10), "Underwater Facility and Non-Open Water Operations," shall be used as the minimum standard to establish the safety requirements for all NASA neutral buoyancy facilities, equipment, personnel, and operations involving underwater activities that provide simulation of a weightless environment. This standard also applies to NASA personnel participating in underwater operations at non-NASA facilities.

6.14 Launch Vehicle and Spacecraft Operations Safety

This paragraph provides policy and requirements for minimizing the risk to the public, operations personnel (including flight crews), public property, and Government property during launch vehicle (missile) and spacecraft launch and flight operations. It also covers the subjects of NASA Headquarters safety representatives, range safety, spacecraft safety, and space debris safety.

6.14.1 NASA Headquarters Safety Representatives.

A NASA Headquarters-designated (can be delegated) safety representative supports each launch of a NASA-managed crewed or robotic launch vehicle, including orbital and other vehicles as determined or delegated by the AA/OSMA. These representatives monitor the preparations of each NASA launch vehicle and NASA payload for flight, evaluate the readiness of the vehicle and payload, and provide the appropriate NASA manager a concurrence or non-concurrence on the readiness of the vehicle and payload to begin launch and flight operations. The representatives are assigned a position on the launch operations communications network and are responsible for determining the NASA Headquarters safety concurrence with the readiness for launch and communicating that status to the appropriate person on the network.

6.14.2 Range Safety.

This subparagraph provides requirements for range safety, which includes launches for which there is a NASA involvement. It includes, but is not limited to, launches from a NASA range, using a NASA payload, a NASA-contracted launch service or NASA funds; or involving NASA on an advisory basis.

6.14.2.1 National Ranges.

NASA space launches are primarily conducted from three national ranges: the Eastern Test Range (ETR, 45th Space Wing) and Western Test Range (WTR, 30th Space Wing) both operated by the DOD, and the Wallops Flight Facility (WFF) operated by NASA.

Policy, requirements, and procedures to ensure the safety of personnel, facilities, and equipment placed at risk during operations on these ranges are delineated in the following range safety requirements documents:

a. Eastern and Western Test Range Regulation (EWR) 127-1, "Range Safety Requirements."

b. Kennedy Handbook (KHB) 1700.7, "STS Payload Ground Safety Handbook," for Shuttle Payloads.

c. Goddard Procedures Guidebook (GPG) 1771.1, "Range Safety for WFF."

The launch responsibilities of NASA and the 45th and 30th Space Wings are defined in joint operating support agreements. These agreements assign responsibility for all in-flight safety to the test ranges, ground safety at Cape Canaveral Air Force Station to the 45th Space Wing at Patrick Air Force Base, and ground safety at Kennedy Space Center to NASA. The 30th Space Wing at Vandenberg Air Force Base is responsible for both in-flight and ground safety.

Other NASA missile and aircraft test flight operations may be conducted at other ranges such as White Sands Missile Range (WSMR), NM, Air Force Flight Test Center (AFFTC) at Edwards Air Force Base, CA, and the Eglin Test Range, FL. For these ranges, the applicable policy, requirements, and procedures of the host range (as well as NASA requirements) shall be followed.

In all cases, flight termination and control protocols will be in accordance with the requirements of the host range and will be consistent with the guidelines in NPG 2810.1, "Security of Information Technology."

Launches conducted at non-NASA ranges shall comply with that range's policies; however, the criteria of this paragraph shall be considered the minimum requirements for safe operations by range users, NASA personnel, and NASA contractors. When range requirements conflict, the most stringent requirement shall dominate.

6.14.2.2 Centers.

a. The Center responsible for coordinating the NASA participation in the launch operation shall ensure conduct of a coordinated range safety effort. The Center also ensures that the hazards associated with the launch of space vehicles and test articles in which NASA has a direct interest or involvement are eliminated or minimized. This may include launch vehicle activities from design through test, launch, flight, and recovery.

b. The Center will ensure that the user submits a comprehensive Safety Data Package prior to approval for payload processing and launch. Users will submit these safety packages to the appropriate Range Safety Office (RSO). When requested, copies will also be provided to Safety and Risk Management Division, NASA (Sponsor) Centers, and the Launch Vehicle Program.

c. Centers shall comply with established national range policy, requirements, and procedures.

d. Centers shall ensure the safety of NASA personnel and resources and minimize risks to the public (personnel and property). If appropriate, and the resources or systems involved are considered mission critical, the additional security and screening criteria of the personnel reliability program will be imposed.

6.14.2.3 Commercial Launch Operations.

For commercial ventures funded by NASA or commercial launches carrying a NASA payload, the launch service providers will provide a proper safety program. NASA SMA representatives will oversee the vehicle preparation, payload integration, and launch operations as outlined in the NASA Headquarters commercial launch vehicle standards. See NASA-STD-8709.2, "NASA Safety and Mission Assurance Roles and Responsibilities for Expendable Launch Vehicle Services," and NASA-STD-8719.8, "Expendable Launch Vehicle Payload Safety Review Process."

6.14.2.4 Range Safety Officer.

Each Center responsible for a launch or aeronautics range will designate a Range Safety Officer. The Range Safety Officer shall protect the general public and public property from harm or damage resulting from the debris or impact of hazardous components from an errant vehicle (stage) or catastrophic flight. Additionally, the officer shall use and certify the operation and maintenance of the range safety system that is comprised of a range safety display system, range clearance capability, radar, optic and telemetry tracking, and display systems, and may include command control capability for a flight termination system. Although the risk associated with space-vehicle launches can never be eliminated completely, the range safety function is to minimize risk while not unduly restricting the probability of mission success.

6.14.2.5 Development and Operations Planning

To reduce costly safety engineering changes to aerospace systems for operation at any range, range safety personnel shall be involved in the early concept stage of development and operations planning. The appropriate Center shall notify NASA Headquarters and the designated range safety organization of preliminary design reviews (PDR's) and critical design reviews (CDR's). The NASA Headquarters designated safety representative and range safety personnel should attend PDR's and CDR's which involve safety-critical systems or operations. Each program manager must ensure adequate funding is available to support this requirement.

6.14.2.6 Readiness Reviews and Audits.

Each program that uses a range shall provide documentation for range safety reviews. The documentation shall include vehicle and payload descriptions, range requirement and compliance documents [Accident Risk Assessment Report (ARAR) and Missile Systems Prelaunch Safety Package (MSPSP)], flight plan, missile system prelaunch operation plan, descriptions of flight termination system, descriptions of radionuclide, and any range safety waiver requests. Submittal of all documentation shall allow sufficient lead-time for a complete review prior to launch. The balloon and sounding rocket programs are not included in the NASA Headquarters review unless specific requests for information are made.

6.14.2.7 Mishap Reporting and Investigation.

To ensure proper mishap investigation, each program or project office shall complete a pre-mishap contingency plan in a reasonable time to allow for coordination before launch. NPD 8621.1, "NASA Mishap Reporting and Investigating Policy," contains the policy and NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping," contains the procedures and guidelines.

6.14.3 Space Debris Safety.

The NASA safety policy for space debris is contained in NPD 8710.3, "NASA Policy for Limiting Orbital Debris Generation." This policy requires each program involved in spacecraft launch and/or deployment to formally assess and minimize the potential for generation of orbital debris and summarize this in a formal report to Headquarters. NASA-STD-8719.14 (formerly NSS 1740.14), "Guidelines and Assessment Procedures for Limiting Orbital Debris," may be used for both the preliminary and final assessment.

6.15 Test Operations Safety

This paragraph provides direction for protecting persons and property during test operations, for both human and unoccupied or robotic tests. Testing also includes hazardous training activities and demonstrations of test hardware or procedures. The requirements stated herein apply to test facilities; test equipment located within, or attached to, test facilities; equipment being tested; test personnel; test conduct; and test documents. Additional requirements are detailed in Chapters 1 and 3 and in other paragraphs of this chapter.

6.15.1 Test Plans.

Test plans shall be developed and evaluated to ensure test performance within safe operating limits. Evaluations will address the test article, test facility, operator involvement, test conditions, potential risk to adjoining facilities and personnel, etc.

6.15.2 Safety Documentation.

Safety documentation establishes the basis for safe test conduct by means of engineering analyses (including hazard analyses calculations). Established test controls will be clearly identified in test drawings, facility drawings, test procedures, etc. The level of safety documentation required will be tailored to the risks involved with the test.

6.15.3 Test System Requirements. Personnel responsible for developing test systems must do the following:

6.15.3.1 Design test systems such that test personnel or critical test hardware are not subjected to a test environment wherein a credible single-point failure (e.g., power loss) could result in injury or loss to the critical test hardware.

6.15.3.2 Construct all systems (electrical, mechanical, pneumatic, and/or hydraulic) so that no single failure could cause a critical condition.

6.15.3.3 Ensure that software that may interface with test systems meets the requirements stated in Chapter 3. Software by itself is not hazardous; however, when interfaced with test hardware, software could command a hazardous condition in the hardware. See NASA-STD-8719.13 (formerly NSS 1740.13), "NASA Software Safety Manual," for further information.

6.15.3.4 Calibrate and certify safety-critical instrumentation before test operations and as required by test documentation or the test organization's internal procedures.

6.15.3.5 Ensure all personnel involved in tests are informed of potential hazards, safety procedures, and protective measures.

6.15.3.6 Ensure the availability of appropriate emergency medical treatment facilities.

6.15.3.7 Conduct formal reviews of those engineering designs that are complicated or potentially hazardous to facilities.

6.15.3.8 Ensure test reports include anomalies, safety implications, and lessons learned.

6.15.4 Test Readiness Review.

Test Readiness Reviews must be conducted for tests involving new or modified hardware and/or procedures. These reviews shall determine the safety, technical, and operational readiness of the test.

6.15.5 Pre-test Meeting.

A pre-test meeting must be conducted with all involved personnel to discuss the research facility, design, instrumentation, safety, and operator training and certification. The meeting should also establish the test plan, identify test constraints to ensure facility safety, and determine test article readiness.

6.15.6 Human Research Subjects.

The requirements for the protection of human research subjects are contained in NPD 7100.8B, "Protection of Human Research Subjects," and 45 CFR Part 46, "Protection of Human Subjects." In addition to the requirements regarding confined spaces cited in paragraph 6.19, crewed test systems shall meet the following criteria:

6.15.6.1 Tests involving hazardous substances, where human test subjects or test team personnel may be exposed, will be reviewed for adequacy of test team safeguards, including direct communication between the test subjects and test conductors.

6.15.6.2 For tests requiring crew participation in a pressure suit, a facility environmental control system failure or failure in the distribution system affecting one pressure-suited occupant shall not affect any other pressure-suited occupant.

6.15.6.3 A means shall exist of immediately detecting an incipient fire or other hazardous condition in each crew compartment of any test area. Automatic detection shall be provided for critical areas not suitable for visual monitoring.

6.15.6.4 Crewed test systems shall be designed for timely and unencumbered rescue of incapacitated crew members.

6.15.6.5 Software controlling crewed test systems shall be thoroughly analyzed to ensure that no command could result in death or injury to the test subjects.

6.15.6.6 Crewed test systems shall be designed to provide for manual overrides of critical software commands to ensure the safety of test subjects during any system event or test scenario (normal operation, malfunction, emergency, etc.). Such overrides shall support safe test termination and egress of test subjects as appropriate.

6.15.6.7 Medical resources and facilities needed for response will be alerted, on-call, and immediately available as needed.

6.16 Non-Ionizing Radiation

Microwave and radar protection standards are covered in various State regulations, national consensus standards, and Federal standards including 29 CFR 1910.97. This paragraph provides directives for protecting persons and property during laser use in NASA operations. The primary laser hazard to humans is eye and/or skin damage from direct exposure to the beam or specular reflection, and in some cases, viewing the diffuse reflection. Laser operations during any open-air laser scenario conducted on Department of Defense (DOD) controlled ranges or test facilities or by DOD personnel will use Document 316-91, "Laser Range Safety," for guidance.

6.16.1 Requirements.

6.16.1.1 21 CFR Part 1040 provides that people shall not be exposed to laser radiation in excess of the maximum permissible limits and prescribes protective measures.

6.16.1.2 NASA procedures and requirements are as follows:

a. Prevent exposure of personnel to laser radiation exceeding the permissible exposure levels. Permissible exposure levels are in ANSI Z136.1, "American National Standard for Safe Use of Laser."

b. Ensure to the maximum extent practical, hazards to personnel are eliminated, or procedures are developed and equipment provided for those hazards that cannot be eliminated by engineering design. This must occur before laser systems become operational.

c. Procure or manufacture only laser products that comply with the performance standards of 21 CFR's 1040.10 and 1040.11, unless a specific exemption is obtained from the U.S. Department of Health and Human Services, Food and Drug Administration (FDA).

d. Ensure that laser operation conforms to the principles and requirements set forth in ANSI Z136.1, "American National Standard for Safe Use of Laser," and ANSI Z136.2, "Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources."

e. Ensure that any laser that can cause injury or damage has a Center-approved safety permit, test plan, or test procedure review.

6.16.1.3 Where a planned laser operation has the potential of the beam striking an orbiting craft, the program manager or designated laser radiation safety officer shall contact the laser safety clearing house to obtain a "Site Window" clearance. The clearance is obtained from the Orbital Safety Officer, U.S. Space Command/J3SOO, 1 NORAD Road, Suite 9-101, Cheyenne Mountain AFB, CO 80914-6020, Stop 4, Phone: (719) 474-3056/4404/4444.

6.16.1.4 A qualified laser radiation safety officer shall review procedures for all tests that use lasers. An individual designated/approved by the Center safety organization will be on site to monitor all laser tests.

6.16.2 Ground Operations Using Class III-B and IV Lasers.

During ground operations using Class III-B and IV lasers, users shall do the following:

6.16.2.1 Operate Class III-B and IV lasers only in controlled environments or designated areas that have no unintended reflective or transmitting surfaces.

6.16.2.2 Post the laser operations area with standard warning placards as set forth in ANSI Z136.1 and ensure the area is isolated to prevent inadvertent entry.

6.16.2.3 Require laser goggles or other approved methods of eye protection in accordance with requirements of ANSI Z136.1.

6.16.2.4 Keep all flammable materials/vapors away from any laser during operation unless specifically authorized by the operation/test plan.

6.16.3 Airborne Operations Using Class III-B and IV Lasers.

6.16.3.1 Program managers must identify use of Class III-B and IV lasers early in the system acquisition process and track their use during the program life cycle. A realistic application of safety engineering to laser systems can avoid or reduce the costs involved in redesign, time lost in modification, and loss of mission capability. Program managers and safety evaluators shall assess the safety aspects, compliance with safety requirements, and resolution of laser safety-related problems.

6.16.3.2 Design of laser systems for NASA aircraft and spacecraft shall include a system of interlocks to prevent inadvertent exposure to laser beam output. When a test circuit switch is provided to override the ground interlock to aid ground test operations, maintenance, or service, design must preclude inadvertent operation.

6.16.3.3 The crew shall not operate the laser except in accordance with the prescribed mission profile. The craft commander shall ensure that the laser system is used in accordance with the test plan.

6.16.3.4 For long-range laser shots, program managers shall designate as large an exclusion area as practical to minimize the risk to the people outside the area. A buffer area should be added around the exclusion area. Air Force AFOSH Standard 48-12, "Health Hazard Control for Laser Operations," includes a guide for operation of lasers from aircraft. It can be used to develop the buffer zone for space-based laser shots directed at the ground. (See Range Commanders Council (RCC) Document 316-91, "Laser Range Safety.")

6.16.3.5 Program managers shall ensure a hazard evaluation and written safety precautions are completed prior to airborne laser operations. Hazard analysis shall consider catastrophic events and the need for very reliable, high-speed laser shutdown should such events occur. (See ANSI Z136.1 for hazard evaluation and control information.)

6.16.3.6 Qualified personnel shall perform laser hazard evaluations to determine specific hazards associated with specific uses, establish appropriate hazard control measures, and identify crew and public-at-large protection requirements.

6.16.3.7 When completing the hazard evaluation, the program manager shall consider and document the atmospheric effects of laser beam propagation, the transmission of laser radiation through intervening materials, the use of optical viewing aids, and resultant hazards, e.g., electrical, cryogenic, toxic vapors.

6.16.4 Software.

6.16.4.1 Software shall provide safety precautions for fast-moving lasers and prevent misdirected laser operation.

6.16.4.2 Laser software development shall be subjected to a software safety analysis per Chapter 3. Existing systems are exempt but shall be reviewed to ensure the provision of safety precautions. See NASA-STD-8719.13 (formerly NSS 1740.13), "NASA Software Safety Manual," for further information.

6.16.5 Training.

Only trained and certified employees shall be assigned to install, adjust, and operate laser equipment. Personnel operating lasers shall be trained and certified in accordance with Chapter 4 of this NPG.

6.17 Ionizing Radiation

Policies and guidance for handling, use, and storage of radioactive material are contained in directives under the purview of the occupational health organizations. See NPD 1800.2, "NASA Occupational Health Program."

6.18 Confined Spaces

6.18.1 A confined space is any space not normally occupied by personnel, has limited or restricted openings for ventilation, access and exit, and may contain chemicals that could produce dangerous air contamination. Entry into confined spaces requires written procedures and authorizations. No entry into confined spaces will be made until an assessment of that space has been made and a permit or operating procedures posted. Supervisors have overall responsibility for entry and work in confined spaces and for ensuring that the requirements of the references below are followed.

6.18.1.1 NASA Health Standard (NHS)/IH-1845.2, "Entry Into and Work in Confined Spaces."

6.18.1.2 OSHA 29 CFR 1910.146, "Permit Required Confined Spaces."

6.18.1.3 American National Standards Institute (ANSI) Z117.1, "Safety Requirements for Confined Space."

6.18.1.4 NIOSH Publication No. 87-113, "A Guide to Safety in Confined Spaces."

CHAPTER 7. Aviation Safety

7.1 Purpose

This chapter provides the basic requirements of the NASA Aviation Safety Program and provides guidance for managers and aviation safety personnel to establish/implement their aviation mishap prevention programs. NASA philosophy is that mishaps are preventable and that mishap prevention is an inherent function of leadership and management. NASA`s major involvement in aeronautics dictates a commitment to aviation safety, under not only the Aviation Safety Program but also in technology programs. Aviation safety must be enhanced through a comprehensive and proactive program covering all aspects of flight.

7.2 Aviation Safety Program

7.2.1 The NASA Aviation Safety Program requires aviation safety measures to be in effect at each level of aviation management. Under this concept, the director/aviation manager responsible for aviation safety and risk management at each level is assisted by an aviation safety officer (ASO)/manager who is an integral part of the aviation manager`s staff and not part of a separate safety organization. The program is supported by system safety personnel as required. Headquarters safety personnel will conduct reviews (staff assistance visits, safety inspections, and process verifications) to provide insight and monitor management`s effectiveness in aviation safety. Headquarters safety personnel will also provide technical and operational assistance to improve the overall safety program.

7.2.2 The highly diversified aviation activities within NASA require a tailored Aviation Safety Program for Headquarters and each flight activity. The primary responsibility for each Center`s Aviation Safety Program rests firmly with the Center Director. The Associate Administrator for Headquarters Operations is responsible for NASA Headquarters aviation operations. Aviation safety programs shall follow the applicable guidelines for each respective flight activity set forth in this chapter; NPG 7900.3 (V1), "Aircraft Operations Management Manual;" and NPG 7900.3 (V2), "Mission Management Aircraft Operations Manual."

7.3 Program Responsibilities and Requirements

The NASA Aviation Safety Program is Agencywide, covering several Headquarters Offices and all

Centers. To ensure effective implementation, the NASA Aviation Safety Program shall conform to the NASA`s aviation management structure.

7.3.1 The NASA Administrator is the senior person responsible for Agencywide aviation safety.

7.3.2 The AA/OSMA has been delegated the authority to establish NASA Aviation Safety Program requirements and provide support and independent oversight of NASA aviation safety. The AA/OSMA shall provide the NASA Administrator an independent assessment of NASA`s aviation safety status and provide immediate information on critical safety issues.

7.3.3 The Director, Safety and Risk Management Division, designates the NASA ASO. The NASA ASO provides overall aviation safety oversight and management support for aviation safety. Through this independent oversight function, the ASO shall ensure that Aviation Safety Program requirements are applied at the appropriate levels of responsibility throughout NASA.

7.3.4 NASA ASO shall perform the following:

a. Serve as the Agency independent focal point for NASA aircraft safety issues.

b. Provide systems safety oversight to ensure Headquarters and Center aircraft operations comply with NASA safety policy.

c. Coordinate all OSMA requirements affecting aviation safety or reporting.

d. Ensure there is an effective Agency mishap and incident reporting and corrective action system.

e. Identify aviation safety issues through mishap investigation and analysis.

f. Serve as ex-officio board member or provide a designee to major aircraft mishap investigations and provide independent oversight and expert guidance in investigation procedures and techniques.

g. Participate in the annual NASA ASO meeting.

h. Monitor and promote Agencywide awareness of and motivation for the Aviation Safety Program.

i. Attend selected program flight readiness and safety reviews.

j. Serve as an advisor to the Intercenter Aircraft Operations Panel (IAOP) and participate in IAOP activities, including meetings, reviews, and subpanel activities.

k. Develop the NASA Aviation Safety Reference Guide (QS-ASO-92-001) and ensure that it is current and meets the needs of NASA.

l. Monitor and act on the aviation safety needs of the Headquarters Enterprise and Program Offices, Aircraft Management Office (AMO), IAOP and its subpanels, and Centers.

m. Interface with other safety organizations.

n. Advocate aviation safety research.

o. Conduct aviation safety staff assistance visits and reviews.

p. Coordinate recommendations from mishap investigations that require corrective action from sources or agencies outside of NASA.

q. Participate in selected aircraft flight operations.

7.3.5 The Associate Administrator for Management Systems, in accordance with NHB 7900.3 (V1), is responsible for policies and other matters related to NASA aircraft management. This includes developing guidelines for safe aircraft operations and implementing an Agencywide Aviation Safety Program in accordance with Agency policies.

7.3.6 Enterprise Associate Administrators and Institutional Program Officers have line management responsibility for aviation safety for their respective Centers/flight operations. This requires ensuring implementation of aviation safety programs for their Centers, allocating aviation resources to meet objectives/programs safely, promulgating safety awareness, conducting mishap investigations, and developing/implementing corrective action.

7.3.6.1 A senior single point of contact for aviation safety and aviation management shall be designated within these offices to provide liaison with the OSMA and the Office of Management Systems.

7.3.6.2 Except for NASA aircraft operations that are the function of the Office of Management Systems, the Associate Administrator for Aeronautics and Space Transportation Technology manages aviation safety-related technology and research programs.

7.3.7 The Aerospace Safety Advisory Panel (ASAP).

The ASAP was established as an advisory committee to NASA by Section 6 of the NASA Authorization Act, 1968 (PL 90-67, codified as 42 U.S.C. 2477). The ASAP reviews and evaluates program activities, systems, procedures, and management policies and provides assessment of these areas to NASA management and Congress. It is in this role that the ASAP provides independent advice on NASA aviation safety issues to the AA/OSMA and to the Administrator.

7.3.8 The Center Director is the primary NASA official responsible for ensuring the safe operation of all aircraft assigned to the Center, and for establishing and implementing an Aviation Safety Program tailored to the Center`s aircraft/airfield operations. They are assisted by NASA Headquarters staff assistance visits and the reports and recommendations of the IAOP and ASAP.

7.3.9 Center aviation manager of flight operations is the senior line person assigned aircraft operations responsibilities. The manager depends on the local ASO to identify mishap potential and assist in administering the mishap prevention program. However, the manager cannot delegate the line responsibility for the prevention of mishaps. A manager`s experience, leadership, and philosophy are decisive factors in ensuring safe operations. Aviation managers of flight operations shall ensure the following:

7.3.9.1 Flight rules, regulations, and other advisory material required for safe flight operations are obtained/published and updated, and all personnel comply with them. Where local conditions or special mission requirements dictate, special rules/procedures should be established and followed.

7.3.9.2 Restrictions to flight, notice to airmen (NOTAM), weather (WX), and other pertinent information are readily available prior to initiation of flight operations. Aviation Managers should not waive any safety requirements set by regulations, NPD`s, or other authoritative sources, unless the risk is accepted. In these cases, managers should justify and document their actions in writing, with approval of the Center Director and appropriate Headquarters officials.

7.3.9.3 A crew rest policy is in effect.

7.3.9.4 Functional and effective foreign object damage (FOD) prevention and tool control programs are in effect.

7.3.9.5 Aerial demonstrations involving NASA aircraft, if conducted, encompass the Center top management`s approval to include flight routines, pilot assignment, training prerequisites, and weather limits.

7.3.9.6 Hazardous aircraft maintenance operations, such as fuel cell entry, radar testing, radiographic testing, and high noise engine run-ins, are coordinated with applicable health organizations.

7.3.10 Center Aviation Safety Officer.

Although the ASO`s also serve as pilots at most Centers, the ASO position is a primary responsibility. Because the ASO serves as the manager`s focal point for aviation safety matters, this individual should report directly to the senior aviation manager responsible for risk management. The ASO also acts on behalf of the Center Director when discharging this responsibility. The ASO shall foster aviation safety measures and use all resources available to promote mishap prevention. ASO selection should be based on education, experience, and ability. Ideally, this individual should be on flight status, be current in assigned aircraft, be a graduate of an approved aviation safety course, and have experience in aircraft mishap investigation. To accomplish these tasks, the ASO should refer to the NASA Aviation Safety Reference Guide to ensure appropriate elements are contained in the Center`s aircraft mishap prevention program.

7.3.11 Pilot-In-Command.

7.3.11.1 The NASA aircraft pilot-in-command (PIC) is responsible at all times for the safe operation of the aircraft and the safety of the passengers. The PIC is the final authority as to whether a flight shall be delayed or diverted for reasons of weather, aircraft conditions, or other safety-related considerations.

7.3.11.2 The PIC shall ensure that passenger briefings are conducted and include pertinent egress, safety, and emergency information.

7.3.12 Individual Responsibilities.

All personnel, including contract personnel associated with NASA flight operations, shall conduct aviation-related activities in a safe and responsible manner and in compliance with NASA aviation guidelines and safety programs. Contracts involving or affecting aviation operations shall stipulate compliance with aviation safety requirements. Aviation safety is a personal responsibility of every person involved in aviation-related activities.

7.4 Aviation Safety Program Elements

This paragraph discusses the general elements of an effective Aviation Safety Program. Each Center shall implement an aircraft mishap prevention program that includes the elements appropriate for their operation. Detailed elements are contained in the NASA Aviation Safety Reference Guide.

7.4.1 Aircraft Mishap Prevention Survey/Review.

A NASA Headquarters aviation safety review of each Center is required biennially. The IAOP, with the assistance of the AMO, conducts these formal reviews with independent safety oversight by the Safety and Risk Management Division. Centers should conduct internal surveys during the alternate year. These reviews provide an objective evaluation of aircraft operations, maintenance, crew procedures, and facilities to ensure safe and efficient operation and aircraft usage consistent with assigned goals and Center requirements.

7.4.2 The Aviation Safety Reporting System.

7.4.2.1 A major program jointly sponsored with the Federal Aviation Administration (FAA) is the NASA Aviation Safety Reporting System (ASRS). This program is designed to identify and publicize deficiencies/discrepancies that have potential safety impact on the aviation community. The program does not address mishap reports but rather solicits reports of perceived safety hazards through a system of protected reporting. This system receives, stores, and distributes pertinent data. It also analyzes the data, conducts special studies, and reports on the results.

7.4.2.2 The Office of Management and Budget (OMB) Report Control Number for the ASRS is 04-R-9206, which has been assigned to the Ames Research Center Form 77.

7.4.2.3 All ASO`s shall use the services of the ASRS program, support its objectives, and integrate the program`s output into their local aviation safety program. They shall encourage pilots and other members of the aviation community to submit timely reports of hazardous conditions or incidents as prescribed under the ASRS program.

7.4.3 Aircraft Mishap Reporting and Investigation.

The principles of mishap reporting, investigation, identification of root causes, and corrective action are central to an effective aviation safety program and shall be conducted in accordance with the NPD 8621.1, "NASA Mishap Reporting and Investigating Policy," and NPG 8621.x, "NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping." Close call reporting, investigation, and dissemination of lessons learned is an essential element of mishap prevention.

7.4.4 Incentives and Awards.

All aviation personnel desire both satisfaction and recognition for their achievements. Safe behavior should be recognized and rewarded. Properly used, incentives and awards can be extremely effective in both motivating and maintaining safe behavior. Further information on awards is located in paragraph 1.15 and Appendix C.

7.4.5 Occupational Health, Medical Clearance, Emergency Egress, and Survival.

Close coordination with occupational health and medical officers and aviation personal equipment specialists shall be maintained. This enhances protection of aircrew and passengers by ensuring proper medical clearances for flight duties, adequate training, and properly maintained and functioning emergency survival equipment. The proper care and use of parachutes, egress systems, breathing equipment, protective equipment, and survival gear are subjects for safety surveillance. The aviation medical program and aviation life support equipment are important components of this safety program element.

7.4.5.1 The Aviation Medical Program. The objectives of the Aviation Medical Program are to promote aviation safety and prevent illness and injury of aviators and aviation support personnel. Specific aims are to promote the health and safety of aviation personnel through appropriate preventive medicine practices; ensure a safe, toxic-free environment for aviation personnel; and evaluate personal equipment and the man/machine interface for toxic and hazardous conditions. Managers shall ensure establishment and support of an aviation medicine program tailored to specific needs of aviation personnel supported.

7.4.5.2 Aviation Life Support Equipment. Aviation Life Support Equipment (ALSE) includes helmets, oxygen masks, parachutes, and survival gear. ALSE is a vital link to a comprehensive aviation safety program. The responsibility, accountability, inspection, and maintenance of this equipment should be delegated to support personnel who are familiar with the equipment, experienced and knowledgeable in aviation concept, and aware of the need for ALSE. ALSE school attendance is desirable and encouraged.

7.4.6 Facilities and Equipment.

Adequate flight facilities shall be established, maintained, and inspected. These include airfield, aircrew, maintenance, aircraft service life extension facilities, Crash Fire Rescue (CFR) facilities, and emergency facilities and equipment for offsite operations.

7.4.7 Cargo Safety.

Provisions shall be made for the safe handling and stowing of cargo, including hazardous materials, in NASA aircraft. Additionally, contract carriers and airlift services used by NASA are required to abide by sound safety practices and Department of Transportation (DOT) regulations, including 49 CFR 175, "Carriage by Aircraft," in the transportation of hazardous materials and cargo. Transportation officers shall ensure mixed cargo and passenger loads meet the requirements for safe practices.

7.4.8 Dissemination of Aviation Safety-Related Information and Material.

The best aviation safety material contributes very little to safety programs unless it is read or used by the people who are part of the Aviation Safety Program. Aviation safety managers should ensure that these materials are distributed throughout their Centers and other sites. Safety information that would be of interest Agencywide should be sent to the Safety and Risk Management Division for distribution. This information may assist in saving lives and preserving valuable resources.

7.4.9 Aviation Safety Reference Guide.

Additional information on aviation safety is contained in the "Aviation Safety Reference Guide," QS-ASO-92-001.

7.5 Interfaces with Other Agencies

NASA aviation activities interface with the aircraft industry, DOT/Federal Aviation Administration (FAA), the Department of Defense (DOD), and foreign governments. These resources shall be used fully in aviation safety matters. Centers shall have a process in place with outside organizations to exchange flight information that affects their assigned aircraft.

7.5.1 Interagency Committee for Aviation Policy (ICAP).

The ICAP was established by GSA Order ADM 5420.99, dated August 9, 1989, as directed by revised OMB Circular A-126, issued January 18, 1989. The committee`s goal is to coordinate Governmentwide improvements in efficiency, effectiveness, economy, and safety of Federal executive agency public aircraft activities. NASA is represented on the executive committee by one primary and one alternate representative from the Office of Management Systems, and by representatives from both the Office of Management Systems and Office of Safety and Mission Assurance on the following subcommittees: Regulatory Policy; Safety, Standards, and Training; Data Management Systems; and Acquisition and Disposition. The NASA representatives will keep the NASA aviation community apprised of deliberations and actions forthcoming from the committee.

7.5.2 Department of Transportation.

NASA aviation safety has a direct interest in FAA flight services and facilities used by NASA aircraft. These include departure, enroute, and arrival procedures, the airways, restricted airspace, and local flying/training areas. Cooperation with FAA at the local level should foster a mutual understanding in developing safe aviation control procedures. Research and development (R&D) activities present opportunities for NASA/FAA cooperation to enhance safety.

7.5.3 Department of Defense.

Because NASA uses many military airfields and aircraft common to the military services, coordination with the Army, Navy, and Air Force is required. Use of the various military safety publications, cross-exchange of accident prevention data, and participation in joint safety efforts are also required. Safety and accident investigation provisions must be included in joint agreements with DOD agencies for joint use or loan of aircraft.

7.5.4 Industry.

Although this interface is normally through the contracting officer, special safety provisions in contracts shall require exchange of accident information concerning the types of aircraft involved. Safety personnel shall participate in design reviews and inspections during the acquisition phase to ensure proper safety coverage.

7.5.5 Foreign Governments.

Most foreign interface occurs during joint research or exchange programs and aviation shows and displays. The primary purpose of aviation safety is to save lives and property. Aviation safety must not have political or national boundaries. The NASA Aviation Safety Program shall have provisions for exchanges of safety information.

CHAPTER 8. Facility Safety

8.1 Purpose

This chapter establishes safety procedures and guidelines to enhance the safety and mission success aspect of NASA`s facility acquisition, construction, and activation process. Facility operational safety requirements are covered in Chapter 6. Except in case of imminent danger, it is not the intent of this chapter to require upgrades to existing facilities just to meet new codes. Existing facilities undergoing major renovations must meet national consensus code in effect at the time of the renovations. Specific safety tasks to be accomplished to ensure safety during construction, operation, maintenance, and final disposition of the facility will be documented in the Facility Safety Management Plan (FSMP) in accordance with NPG 8820.2, "Facility Project Implementation Handbook." The FSMP for each facility acquisition should be tailored to include those tasks appropriate considering the size and complexity of the project and associated safety risks. NASA-STD-8719.7, "Facilities System Safety Manual," provides a review of the facility life cycle and the safety tasks that shall be accomplished (as applicable) during acquisition, modification, test activities, facilities operations, maintenance, and disposal.

8.2 Applicability and Scope

This chapter is not a direct instruction to NASA contractors who provide planning, architect-engineering (A-E) design, or construction contract services. It is guidance to the responsible NASA Center program/project management, contracting office, safety assurance, and fire protection organization personnel who implement the safety programs essential to meeting each facility acquisition and construction work package effort in accordance with NPG 8820.2, "Facility Project Implementation Handbook." This chapter shall be applied to construction of facilities (CoF) projects and facilities maintenance projects. This chapter shall also be applied to Center-approved projects according to the degree of impact of safety policy and regulatory considerations on those projects. This chapter shall not supersede more stringent requirements imposed by individual NASA organizations and other Government agencies.

8.3 Objectives

NASA`s facility acquisition safety and construction safety objectives are as follows:

8.3.1 Identify, track, and resolve hazards at the earliest possible phase to eliminate risk to personnel safety and mission success and to minimize the cost and need for a retrofit program.

8.3.2 Perform safety oversight functions to ensure compliance with NASA safety policies.

8.3.3 Provide for review of all proposed projects to ensure that all safety requirements are specified and funded.

8.3.4 Provide the necessary technical reviews that include safety aspects of all facility acquisition, design, and construction efforts to ensure that they are being conducted in accordance with sound safety engineering principles.

8.3.5 Monitor facility construction, modification, repair, and rehabilitation for compliance with appropriate safety, fire protection, and building codes and standards. NASA fire protection and safety personnel shall monitor the compliance effort in the various phases of the projects. For projects with safety or fire protection implications, this effort will be formal, with the safety office/fire protection office providing a formal sign-off.

8.3.6 Ensure that any final inspection effort (operational readiness inspection (ORI), operational readiness review (ORR), test readiness review (TRR), pre-final inspection (PFI), final inspection (FI), etc.) includes a safety and/or health representative as appropriate and that all facility safety and health issues are documented, resolved, or adequately controlled prior to acceptance, activation, and operation.

8.3.7 Maintain current building configuration during all phases of the facility acquisition, maintenance, operation, and disposal process. Test activities that require building modification, however minor, are of particular interest. Process any change to facility hardware, software, or procedures through the configuration management (CM) program.

8.3.8 Inspect all facilities, occupied or unoccupied, at least annually.

8.4 Basic Requirements

To achieve facility acquisition, construction, and activation safety assurance objectives, each NASA Center Director shall do the following:

8.4.1 Designate and assign facility safety program management responsibilities to a NASA Center safety and mission assurance organization that is independent from the specific facility (user) management.

8.4.2 Assure that the fire protection and safety organizations review all proposed NASA-owned, controlled, or operated facility configuration changes and construction work change orders that have a potential safety impact. This does not preclude the use of checklists and other guidelines to assist the project in determining the potential safety or fire impact and necessary protection requirements.

8.4.3 Incorporate safety criteria or requirements into the project design criteria before start of facility project design, in accordance with NPG 8820.2, "Facility Project Implementation Handbook."

8.4.4 Mandate compliance with NASA supplementary and alternate NASA technical standards for safety that may apply for all NASA-managed construction work. For construction undertaken at NASA by the U.S. Army Corps of Engineers, compliance with EM 385-1-1, "U.S. Army Corps of Engineers, Safety and Health Requirements," is mandatory. For related NASA-managed projects, EM 385-1-1 will be considered as an advisory document.

8.4.5 Ensure facility operation instructions and changes are developed based on the facility mission and operational requirements. All procedures shall include sufficient detail to identify residual hazards and cautions to NASA personnel. A written preventative maintenance program must be developed that includes schedules, procedures, and records. Deviation or changes to hazardous operating procedures (HOP`s) require the approval of the cognizant NASA/contractor safety or health offices. Those procedures and instructions identified as hazardous shall require fire protection and safety office approval as provided in Chapter 6.

8.5 Facility Managers

The Center Director or designee shall appoint a facility operations manager or facility coordinator to oversee proper operation of the facility. A safety coordinator may be appointed to assist the manager. The extent of each authority shall be detailed in writing to ensure complete safety coverage of all facility operations. The Center safety office will interface with the facility managers or safety coordinators as appropriate to ensure proper safety program implementation.

8.6 Facility Safety Management Plan

8.6.1 The Center Directors shall document and maintain a written facility FSMP for each major facility acquisition, modification, test activities, operations and maintenance, and disposal to monitor timely completion of all required life cycle safety program tasks. The FSMP should include a facility hazard analysis (FHA), hazard analysis tracking index (HATI), and hazard resolution verification (HRV). NASA-STD-8719.7, "Facilities System Safety Manual," provides a detailed explanation of these requirements. As part of the FHA, the risk assessment code (RAC) system for facilities is used to indicate the risk associated with each individual hazard that considers the severity and probability of a hazard. The FSMP may be contractually proposed or prepared in-house. This plan shall be used to implement tailored safety requirements, including organizational responsibilities, resources, milestones, methods of accomplishment, depth of effort, and integration with other program engineering and management activities and related systems. For minor or normal acquisitions and facility modification projects, the FSMP can be tailored but will include the appropriate local directives, instructions, and guidelines as a minimum.

8.6.2 The FSMP shall contain a realistic milestone schedule commencing with the functional requirements and facilities concept development phase to monitor timely completion of all required safety program tasks for the facility project design. The milestone schedule shall also include safety management during construction, and the operation and maintenance considerations (instructions, training, provisioning of parts, special tools, and supplies) cited in NPG 8831.2, "Facilities Maintenance and Energy Management Handbook," for complex facility projects or the use of specialized equipment. All FSMP milestones shall support the scheduled facility need date or occupancy date, as appropriate.

CHAPTER 9. Fire Safety

9.1 Purpose

This chapter establishes the overall requirements for the NASA Fire Safety Program.

9.2 Objectives and Goals

The objective of NASA fire safety policy is to protect human life, property, and the environment from the risk of fire-related hazards. The goals are zero loss of life from fires, a reduction in number of fires to zero, protection for facilities and equipment to preclude major losses, and a reduction in the magnitude of loss for those fires that occur.

9.3 General

NASA shall implement a comprehensive fire safety program at each NASA Center. This program is further defined by specific program requirements and procedures found in NASA-STD-8719 (formerly NSS 1740.11), "Safety Standard for Fire Protection." The program generally provides for the following:

9.3.1 Providing appropriate automatic fire detection and suppression systems for all facilities containing significant hazards, mission essential equipment, or permanently housed personnel in accordance with 29 CFR 1910 Subpart L.

9.3.2 Complying with National Fire Protection Association (NFPA) and other nationally recognized building and fire safety codes and any applicable local codes in accordance with 40 U.S.C. Section 619, (Section 6(a) of Public Law 100-678, "Public Buildings Amendments of 1988," November 17, 1988), as amended.

9.3.3 Ensuring employees, other than trained professional firefighters, trained volunteers, or emergency response personnel, do not fight fires except in cases where the fire is incipient in nature.

9.3.4 Adhering to the more stringent of fire safety requirements imposed by local, State, or Federal agencies.

9.4 Responsibilities

9.4.1 The Center Director is responsible for identifying and reducing fire risks, ensuring fire safety of its operations, and implementing the directives of this chapter. Centers are responsible for following applicable government laws and requirements for fire protection and life safety in construction and building codes as well as ensuring implementation of NASA operational fire safety procedures.

9.4.2 The Center Director shall appoint the Authority Having Jurisdiction (AHJ) for NASA fire protection in writing. That person shall be a safety or fire protection professional with requisite skills and knowledge to fulfill the role. For specific responsibilities of the AHJ, refer to NASA-STD-8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection."

9.4.3 Each Center`s fire and safety organization shall review and approve all project design criteria and conceptual plans and design documents with life safety and/or fire protection/prevention implications.

9.5 Fire Protection Surveys and Inspections

Fire hazards will be identified through comprehensive fire risk evaluation, discrepancies documented, and abatement plans prepared for corrective action. Those items that cannot be corrected or funded locally must be forwarded to Headquarters for resolution. Engineering surveys and fire inspections will be conducted and documented.

9.6 Fire Protection Systems

9.6.1 Fire Protection Doctrine.

The nature of NASA`s mission is such that a significant number of specialized facilities and operations exist along with the more conventional structures and work routines. As a result, difficulties arise in the determination of the required level of fire safety. In most instances, conventional fire protection doctrine and existing codes and standards are appropriate. However, specialized facilities may have fire risks not specifically addressed by conventional means. In those instances, safeguards can be assured by following the guidance outlined in this document and in NASA-STD-8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection."

9.6.2 Extinguishing Systems.

Extinguishing systems and fire extinguishers shall comply as a minimum with the National Fire Protection Association (NFPA) codes and standards. All fire protection equipment shall be Underwriter Laboratories (UL) listed or Factory Mutual (FM) approved.

9.7 Firefighting

Firefighting organizations may be established or provided to ensure adequate protection to life and property. NFPA recommendations and OSHA regulations shall be used for determining type, size, and training of firefighting organizations. When agencies external to NASA provide fire protection, the agreed-upon arrangement must be documented and retained on file.

9.8 Emergency (Pre-Fire) Planning and Procedures

Specialized facilities and critical areas that constitute a major portion of NASA operations demand a unique, pre-planned response from the entire Agency. See NPD 8710.1, "Emergency Preparedness Program," NASA-STD-8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection," and respective emergency preparedness plans for further information on specific critical areas and emergency plan procedures.

9.9 Fire Safety Training

Training for NASA employees shall be in accordance with the requirements and guidelines contained in Chapter 4 of this document; 29 CFR 1910.38, Employee Emergency Plans and Fire Prevention Plans; and NASA-STD-8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection."

9.10 Reporting

Reporting shall be an integral part of fire safety. Effective reporting procedures disseminate the knowledge and experience gained by one Center to the rest of NASA and the Federal Government. Reporting of fire-related mishaps shall be in accordance with NPD 8621.1, "NASA Mishap Reporting and Investigating Policy."

9.11 Regulations, Codes, and Standards

With the goal of protecting life and property, NASA organizations must comply with the most current requirements of the following documents in the design, construction, and operation of all NASA buildings and structures. (Conflicts shall be documented in accordance with the variance policy of paragraph 1.19 and sent to NASA Headquarters for review.) When standards are updated and superseded by newer, more stringent requirements, the AHJ will perform a risk assessment and determine on a case-by-case basis the need to incorporate the newer requirements and standards into existing facility and equipment operating procedures.

9.11.1 Federal Documents.

9.11.1.1 40 U.S.C. Section 619, "Compliance with Nationally Recognized Codes," (Section 6(a) of P.L. 100-678, November 17, 1988), as amended.

9.11.1.2 29 Code of Federal Regulations (CFR) Part 1910 Subpart L, Fire Protection.

9.11.2 NASA Documents.

9.11.2.1 NASA-STD-8719.11 (formerly NSS 1740.11), "NASA Safety Standard for Fire Protection." This standard contains specific NASA requirements and guidelines for the implementation of a comprehensive fire protection program.

9.11.2.2 NASA STD 6001, "Flammability, Odor, Off-gassing and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion." This Handbook contains methods to assess flammability of materials.

9.11.2.3 NASA-STD-8719.7, "Facility System Safety Manual."

9.11.3 Other Standards.

The use of NFPA standards, including their appendices, is mandatory unless the requirements of the local codes are more stringent (see paragraph 9.3.2). Mandatory standards that need to be addressed are as follows:

9.11.3.1 A nationally recognized building code or the appropriate local building codes.

9.11.3.2 NFPA fire standards, codes, and their appendices.

9.11.3.3 NFPA Life Safety Code Handbook.

9.11.3.4 NFPA National Electric Code Handbook.

APPENDIX A: Acronym and Abbreviation List

A-E	Architect-Engineering
AA	Associate Administrator
AFB	Air Force Base
AFFTC	Air Force Flight Test Center
AFOSH	Air Force Occupational Safety and Health
AHJ	Authority Having Jurisdiction
ALARA	As Low As Reasonably Achievable
ALSE	Aviation Life Support Equipment
AMO	Aircraft Management Office
ANSI	American National Standards Institute

ARAR	Accident Risk Assessment Report
ARC	Ames Research Center
ASAP	Aerospace Safety Advisory Panel
ASO	Aviation Safety Officer
ASRS	Aviation Safety Reporting System
CDR	Critical Design Review
CFR	Code of Federal Regulations
	Crash, Fire, Rescue
CIL	Critical Items List
CoF	Construction of Facilities
COTR	Contracting Officers Technical Representative
CSFP	Critical Single Failure Point
CSC	Critical Software Command
DASHO	Designated Agency Safety and Health Official
DCMC	Defense Contracting Management Command
DCN	Document Control Number
DCR	Design Certification Review
DLAM	Defense Logistics Agency Manual
DoD	Department of Defense
DOE	Department of Energy
DoL	Department of Labor
DOT	Department of Transportation
ELV	Expendable Launch Vehicle
EM	Engineering Memorandum
	Electronic Mail
	Exception Monitor
EO	Executive Order
EPA	Environmental Protection Agency
ESD	Electrostatic Discharge
ETA	Event Tree Analysis
ETR	Eastern Test Range
EWR	Eastern and Western Test Range Regulation
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FDA	Food and Drug Administration
FHA	Facility Hazard Analysis
	Fault Hazard Analysis
FI	Final Inspection
FM	Factory Mutual
FMEA	Failure Modes and Effects Analysis
FOD	Foreign Object Damage
FRR	Flight Readiness Review
FSMP	Facility Safety Management Plan
FTA	Fault Tree Analysis
GAO	General Accounting Office
GFE	Government Furnished Equipment
GFF	Government Furnished Facilities
GFP	Government Furnished Property
GPG	Goddard Procedures Guidebook
GRC	Glenn Research Center at Lewis Field
GSA	General Services Administration

GSE	Government Supplied Equipment
	Ground Servicing/Support Equipment
GSFC	Goddard Space Flight Center
HAB	HEDS Assurance Board
HEDS	Human Exploration and Development of Space
HOP	Hazardous Operating Procedure or Hazardous Operating Permit
HR	Hazard Report
IAOP	Intercenter Aircraft Operations Panel
ICAP	Interagency Committee for Aviation Policy
IHA	Integrated Hazard Analysis
	Interface Hazard Analysis
INSRP	Interagency Nuclear Safety Review Panel
IRIS	Incident Reporting Information System
ISSIAP	International Space Station Independent Assessment Panel
JANNAF	Joint Army, Navy, NASA, Air Force
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KHB	Kennedy Handbook
KSC	Kennedy Space Center
LaRC	Langley Research Center
LED	Light Emitting Diode
LeRC	Lewis Research Center (now Glenn Research Center at Lewis Field)
LLIS	Lessons Learned Information System
MSDS	Material Safety Data Sheet
MSE	Mission Safety Evaluation
MSFC	Marshall Space Flight Center
MSPSP	Missile System Prelaunch Safety Package
NASA	National Aeronautics and Space Administration
NDE	Nondestructive Evaluation
NEPA	National Environmental Policy Act
NF	NASA Form
NFPA	National Fire Protection Association
NFS	NASA FAR Supplement
NFSAM	Nuclear Flight Safety Assurance Manager
NHB	NASA Handbook
NHS	NASA Health Standard
NIOSH	National Institute of Occupational Safety and Health
NPC	NASA Policy Charter
NPD	NASA Policy Document
NPG	NASA Procedures and Guidelines
NOTAM	Notice to Airmen
NSRS	NASA Safety Reporting System
NSS	NASA Safety Standard
NSTC	NASA Safety Training Center
O&SHA	Operating and Support Hazard Analysis
OEB	Operations and Engineering Board
OHA	Operating Hazard Analysis
OMB	Office of Management and Budget
ORI	Operational Readiness Inspection
ORR	Operational Readiness Review
OSHA	Occupational Safety and Health Administration

OSMA	Office of Safety and Mission Assurance
OSTP	Office of Science and Technology Policy
PAR	Prelaunch Assessment Review
PDR	Preliminary Design Review
PFI	Pre-Final Inspection
PHA	Preliminary Hazard Analysis
PIC	Pilot-in-Command
PL	Public Law
PPE	Personal Protective Equipment
PV	Pressurized Vessel
R&D	Research and Development
RAC	Risk Assessment Code
RADCC	Radiological Control Center
RCC	Range Commanders Council
RSO	Range Safety Office
SAR	Safety Assessment Report
	Safety Analysis Report
SAS	Safety Analysis Summary
SCA	Sneak Circuit Analysis
SCAPE	Self-Contained Atmospheric Protective Ensemble
SCBA	Self-Contained Breathing Apparatus
SCR	System Concept Review
SCUBA	Self-Contained Underwater Breathing Apparatus
SEB	Source Evaluation Board
SER	Safety Evaluation Report
SHA	System Hazard Analysis
SMA	Safety and Mission Assurance
SOLAR	Site for On-line Learning and Resources
SPP	Safety Program Plan
SSARMAC	System Safety and Risk Management Assistance Committee
SSC	Stennis Space Center
SSHA	Subsystem Hazard Analysis
SSM	System Safety Manager
SSP	Space Shuttle Program
SSRP	System Safety Review Panel
STS	Space Transportation System
SWHA	Software Hazard Analysis
TRR	Test Readiness Review
UL	Underwriter Laboratories
V	Volt
WFF	Wallops Flight Facility
WSMR	White Sands Missile Range
WTR	Western Test Range
WX	Weather

APPENDIX B. Glossary of Safety and Risk Management Terms

Acceptance Testing. Tests to determine that a part, component, subsystem, or system is capable of meeting performance requirements over the environmental and operating ranges prescribed in the specification documents.

Accepted Risk. A hazard whose risk is not completely mitigated and that has been accepted by top program and safety management.

Accident Prevention. Methods and procedures used to eliminate the causes that could lead to a mishap.

Action Centers. Emergency centers set up by the appropriate Center official or program official to coordinate all communications, responses, and other actions for mishaps that have international, national, or regional implications; high visibility; or major public interest.

Aviation Life Support Equipment (ALSE). Includes helmets, oxygen masks, parachutes, and survival gear used for aviator safety.

Applied Load (Stress). Actual load (stress) imposed on a system.

Arming. Bringing a device or system to a state or condition that will allow its subsequent activation.

Assessment. Review or audit process, using predetermined methods, that evaluates hardware, software, procedures, technical and programmatic documents, and the adequacy of their implementation.

Audit. Formal review to assess compliance with hardware or software requirements, specifications, baselines, safety standards, procedures, instructions, codes, and contractual and licensing requirements.

Authority Having Jurisdiction (AHJ). The AHJ is the organization, office, or individual responsible for approving equipment, an installation, or a procedure. The AHJ's are to be designated for fire protection and explosives by the Center Director. The fire protection AJH shall be a safety or fire protection professional.

Availability. Measure of the percentage of time that an item could be used as intended.

Biomechanics. Interdisciplinary science (comprising mainly anthropometry, mechanics, physiology, and engineering) of the mechanical structure and behavior of biological materials. It concerns primarily the dimensions and mass properties of body segments.

Buddy System. An arrangement used when risk of injury is high, where personnel work in pairs, with one person in the pair stationed nearby, not directly exposed to the hazard, to serve as an observer to render assistance if needed.

Catastrophic. (1) A hazard that could result in a mishap causing fatal injury to personnel, and/or loss of one or more major elements of the flight vehicle or ground facility. (2) A condition that may cause death or permanently disabling injury, major system or facility destruction on the ground, or loss of crew, major systems, or vehicle during the mission.

Certification Test. Test whose objective is to determine and then certify that system specifications are satisfied or personnel skills are present.

Certified Personnel. Personnel who have completed required training and whose specified knowledge or proficiency in a skill has been demonstrated and documented.

Configuration Item. An item that is designated for configuration management.

Contractor Safety Plans. Written plans prepared by the contractor detailing the overall safety program that will cover the employees, equipment, and facilities used to fulfill the contract.

Contributing Root Cause. A factor, event, or circumstance which led, directly or indirectly, to the dominant root cause, or which contributed to the severity of the mishap.

Controlled (Risk) Hazard. The likelihood of occurrence or severity of the associated undesirable event has been reduced to an acceptable level through the imposition of appropriate, readily implementable, verifiable controls, resulting in minimal residual risk.

Credible Condition (Event). Condition (event) that reasonably may be anticipated and planned for based on experience with or analysis of a system.

Crew Rating. Certifying the incorporation of enhanced environmental support, reliability, and safety features into the design and operation of hardware and software essential for the preservation of life during crewed tests or operations.

Critical. A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.

Critical Lifting Operations. Lifting and lowering operations involving major programmatic or institutional hardware that is irreplaceable, or will cause serious program or mission delays if damaged, or is hazardous to personnel if dropped or uncontrolled, or will require special budgetary actions to repair damages suffered from lifting malfunctions.

Critical Single Failure Point (CSFP). A single item or element, essential to the safe functioning of a system or subsystem, whose failure in a life or mission essential application would cause serious program or mission delays or be hazardous to personnel.

Critical Software Command (CSC). A command that either removes a safety inhibit or creates a hazardous condition.

Design Burst Pressure. Pressure at which an element of a pressurized system would be expected to burst if it meets the exact design conditions.

Design Margin. Percent by which a factor of safety of 1.0 is exceeded or deficient.

Deviation. A variance that authorizes departure from a particular safety requirement where the intent of the requirement is being met through alternate means that provide an equivalent level of safety. OSHA refers to this as an alternate or supplemental standard.

Dominant Root Cause. Along a chain of events leading to a mishap, the first causal action or failure to act that could have been controlled systemically either by policy/practice/procedure or individual adherence to policy/practice/procedure.

Eliminated Hazard. A hazard that has been eliminated by completely removing the hazard causal factors.

Emergency. Unintended circumstance bearing clear and present danger to personnel or property which requires an immediate response.

Event Tree Analysis (ETA). An analysis that traces the effect of a mishap and leads to all possible consequences through visualization of the positive and negative sides for each event using a type of logic tree. Event trees are complements to fault trees. This is an inductive logic method for identifying the various possible outcomes of a given initiating event.

Exposure. (1) Vulnerability of a population, property, or other value system to a given activity or hazard; or (2) other measure of the opportunity for failure or mishap events to occur.

Facility Hazard Analysis (FHA). The FHA is a preliminary hazard analysis performed during the planning and decision phases of a facility design and acquisition program.

Factor of Safety (Safety Factor). Ratio of the design condition to the maximum operating conditions specified during design (see also Safety Margin and Margin of Safety).

Fail-Operational. Ability to sustain a failure and retain full operational capability.

Fail-Safe. Ability to sustain a failure and retain the capability to safely terminate or control the operation.

Failure. Inability of a system, subsystem, component, or part to perform its required function within specified limits.

Failure Analysis. A systematic examination of a failed item or system to identify the failure mode and cause.

Failure Cause. Physical or chemical process, design defect, quality defect, or other process that initiates a sequence of events leading to failure.

Failure Effect. Consequence of a failure mode on the operation, function, or status of an item or system.

Failure Mode. Particular way in which a failure can occur, independent of the reason for failure.

Failure Modes and Effects Analysis (FMEA). A bottoms up systematic, inductive, methodical analysis performed to identify and document all identifiable failure modes at a prescribed level and to specify the resultant effect of the modes of failure. It is usually performed to identify critical single failure points (CSFPs) in hardware. In relation to formal hazard analyses, FMEA is a subsidiary analysis.

Failure Rate. Number of failures per unit of time or other measure of opportunity for failures to occur.

Fault Detection. Process that discovers or is designed to discover faults.

Fault Hazard Analysis (FHA). Analysis performed during design resulting in the identification, evaluation, and control of hazards resulting from piece-part or component faults.

Failure Tolerance. Built-in capability of a system to perform as intended in the presence of specified hardware or software failures.

Fault Tree. A schematic representation resembling an inverted tree that depicts possible sequential events (failures) that may proceed from discrete credible failures to a single undesired final event (failure). A fault tree is created retrogressively from the final event by deductive logic.

Fault Tree Analysis (FTA). An analysis that begins with the definition or identification of an undesired event (failure). The fault tree is a symbolic logic diagram showing the cause-effect relationship between a top undesired event (failure) and one or more contributing causes. It is a type of logic tree that is developed by deductive logic from a top undesired event to all subevents that must occur to cause it.

Firmware. Computer programs and data loaded in a class of memory that cannot be dynamically modified by the computer during processing.

Flight Hardware. Hardware designed and fabricated for ultimate use in a vehicle intended to fly.

Fracture Mechanics. Engineering methods used to predict flaw-growth and fracture behavior of materials and structures containing cracks or crack-like flaws.

Functional Redundancy. A situation where a dissimilar device provides safety back-up rather than relying on multiple identical devices.

Ground Support Equipment. Ground-based equipment used to store, transport, handle, test, check out, service, and control aircraft, launch vehicles, spacecraft, or payloads.

Handlers of Hazardous Material. Individuals who handle but who do not open or otherwise disturb the integrity of the basic, properly packaged, shipping container that holds the hazardous material. As an example, this includes personnel who prepare, package, mark, or transport hazardous material. Personnel who reduce palletized or otherwise combined items into smaller increments, without exposing the hazardous material, are considered handlers.

Hazard. Existing or potential condition that can result in or contribute to a mishap.

Hazard Analysis. Identification and evaluation of existing and potential hazards and the recommended mitigation for the hazard sources found.

Hazard Analysis Report. System safety document that summarizes results of the hazard analyses performed on a system or activity.

Hazard Control. Means of reducing the risk of exposure to a hazard.

Hazard List. Listing of all identifiable and known hazards.

Hazard Prioritization. Used in risk management, ranking of hazards in order of risk severity by program and safety management for formal action to reduce the level of risk.

Hazard Probability. Likelihood of occurrence, stated in qualitative or quantitative terms, of the aggregate of conditions that result in a specific hazard.

Hazard Report (HR) Closure Classification. Report closures are classified as eliminated hazard, controlled hazard, or accepted risk hazard. An HR when closed will have one of the following classifications: Eliminated Hazard, Controlled Hazard, or Accepted Risk.

Hazard Report (HR) Status. Report status is cited as follows:

1. Closed. Corrective action to eliminate or control the hazard has been implemented or scheduled for implementation before the effectivity identified in the HR; or

2. Open. An HR status is open when corrective action to eliminate or control the hazard has not been completed and the corrective action is not scheduled to be performed.

Hazardous Event. Event that contributes to a hazard.

Hazardous Material. Defined by law as "a substance or materials in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce" (49 U.S.C 1802). The Secretary of Transportation has developed a list of materials that are hazardous which may be found in 49 CFR 172.101. Typical hazardous materials are those that may be highly reactive, poisonous, explosive, flammable, combustible, corrosive, radioactive, produce contamination or pollution of the environment, or cause adverse health effects or unsafe conditions.

Hazardous Operation. Any operation involving material or equipment that has a high potential to result in loss of life, serious injury to personnel, or damage to systems, equipment, or facilities.

Hazardous Operation Safety Certification. Certification required for personnel who perform those tasks that potentially have an immediate danger to the individual (death/injury) if not done correctly, could create a danger to other individuals in the immediate area (death or injury), and present a danger to the environment.

High Value. Facilities/equipment valued at 1 million ($1,000,000) dollars and above.

Human Engineering. Area of engineering that applies scientific knowledge to the design of systems and operations to achieve effective human-system integration.

Human Factors Engineering. Area of engineering dealing with human biomedical and psychosocial characteristics. It includes, but is not limited to, principles and applications in the areas of human engineering, personnel selection, training, life-support, job performance aids, and human performance evaluation.

Imminent Danger. Condition or practice that could be reasonably expected to cause death or serious physical harm immediately or in the near term. These are classified as Risk Assessment Code (RAC) 1 using the typical NASA risk assessment matrix in Chapter 3.

Independent Inhibit. An inhibit that will continue to operate independent of other design features.

Independent Verification and Validation. Test and evaluation process by a third party.

Inhibit. Design feature that prevents operation of a function.

Integrated Hazard Analysis. Comprehensive evaluation of hazards, taking into account all subsystems and elements that are included in the overall system being analyzed, including the system, and operational and environmental envelopes.

Interface Hazard Analysis (IHA). Evaluation of hazards which cross the interfaces between a specified set of components, elements, or subsystems.

Interlock. Hardware or software function that prevents succeeding operations when specific conditions are satisfied.

Limit Load. Maximum combination of loads which a structure is expected to experience in a specified operational environment.

Margin of Safety. Deviation of the actual (operating) factor of safety from the specified factor of safety. Can be expressed as a magnitude or percentage relative to the specified factor of safety.

Minor Radioactive Sources. Quantities of minor radioactive sources are defined in terms of the level of review and reporting procedures required.

Mission Critical. Item or function that must retain its operational capability to assure no mission failure (i.e., for mission success).

Mission Safety Evaluation (MSE) Report. A formal report for a specified mission to document the independent safety evaluation of safety risk factors that represent a change, or potential change, to the risk baseline of the program.

NASA Safety Standard (NSS). A NASA safety document that requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes reasonably necessary or appropriate to provide for safe employment and places of operation. The document is promulgated by the NASA Office of Safety and Mission Assurance and implemented and enforced by the Center Safety and Mission Assurance organizations. In 1999 the NSS's were merged into the NASA Technical Standards library and became NASA-STD's.

Noncritical Lifting. A lifting operation whose failure or malfunction (loss of control, dropping a load, etc.) would not cause loss of life, loss of space vehicle, loss of payload, loss of mission essential hardware, or damage to flight or space hardware.

Nondestructive Evaluation (NDE). Test and inspection methods used to determine the integrity of equipment that do not involve destruction of the test object. Examples are ultrasonic, magnetic particle, eddy current, x-ray, dye penetrant, etc.

Nuclear Flight Safety Assurance Manager (NFSAM). The person in the Office of Safety and Mission Assurance responsible to assist the program/project offices in meeting the required nuclear launch safety analysis/evaluation.

Occupational Safety and Health Administration (OSHA). The Federal agency which promulgates and enforces workplace safety regulations and guidance.

Operating and Support Hazard Analysis (O&SHA). An analysis performed to identify hazards and recommend risk reduction alternatives in procedurally controlled activities during all phases of intended use.

Operating Hazard Analysis (OHA). An analysis that examines the operator interface during system operation and maintenance actions. Because the operator actions are not defined until late in the system development program, corrective action resulting from this analysis will seldom be a design change. This analysis also determines certification and training requirements and safety inputs to technical manuals, warning signs, and safety placards.

Operational Safety. That portion of the total NASA safety program dealing with safety of personnel and equipment during launch vehicle ground processing, normal industrial and laboratory operations, special high hazard tests and operations, aviation operations, use and handling of hazardous materials and chemicals from a safety viewpoint, and design, construction, and use of facilities.

Oversight/Insight. The transition in NASA from a strict compliance oriented style of management to one which empowers line managers, supervisors, and employees to develop better solutions and processes.

Potentially Serious. Condition or practice that could reasonably be expected to cause injury or illness over the operational lifetime of the system or process. These are classified as Risk Assessment Code (RAC) 2 using the typical NASA risk assessment matrix in Chapter 3.

Preliminary Hazard Analysis (PHA). A gross study of the initial system concepts. It is used to identify all of the energy sources that constitute inherent hazards. The energy sources are examined for possible accidents in every mode of system operation. The analysis is also used to identify methods of protection against all of the accident possibilities.

Pressure Vessel. Any vessel used for the storage or handling of a fluid under positive pressure. A pressure system is an assembly of components under pressure, e.g., vessels, piping, valves, relief devices, pumps, expansion joints, gages.

Proof Load Test. A load test performed prior to first use, after major modification of the load path, or at other prescribed times. This test verifies material strength, construction, and workmanship and uses a load greater than the rated load.

Radiological Control Center (RADCC). A temporary information clearinghouse established on an as-needed basis to coordinate actions that could be required for mitigation, response, and recovery of an incident involving the launching of nuclear material.

Range Safety. Application of safety policies, principles, and techniques to ensure the control and containment of flight vehicles to preclude an impact of the vehicle or its pieces outside of predetermined boundaries from an abort which could endanger life or cause property damage. Where the launch range has jurisdiction, pre-launch preparation is included as a safety responsibility.

Rated Load Test. A load test performed at predetermined intervals with a load equal to the rated load.

Redundancy. Use of more than one independent means to accomplish a given function.

Residual Risk. Risk that remains from a hazard after all mitigation and controls have been applied.

Risk. The combination of (1) the probability (qualitative or quantitative) that a program or project will experience an undesired event such as cost overrun, schedule slippage, safety mishap, or failure to achieve a needed technological breakthrough; and (2) the consequences, impact, or severity of the undesired event were it to occur.

Risk Contributors List. List of hazards and their associated severity and probability contributing to a risk.

Risk Management. An organized, systematic decisionmaking process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risk to increase the likelihood of achieving program/project goals.

Risk (Safety) Assessment. Process of qualitative risk categorization or quantitative risk (safety) estimation, followed by the evaluation of risk significance.

Safe Haven. A location that affords life saving protection in the event of a maximum credible event.

Safety. Freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Safety Analysis. Generic term for a family of analyses, which includes but is not limited to: preliminary hazard analysis, system (subsystem) hazard analysis, operating hazard analysis, software hazard analysis, sneak circuit, and others.

Safety Analysis Report (SAR). A safety report of considerable detail prepared by or for the program detailing the safety features of a particular nuclear system or source.

Safety Analysis Summary (SAS). A brief summary of safety considerations for minor sources; a safety report of less detail than the SAR.

Safety Assistance Visit. Onsite evaluations by specialists and safety personnel who, after making spot checks and sampling visits and holding discussions with appropriate levels of management, provide informal or formal reports to the affected organization.

Safety Assurance. The attainment of acceptable risk for the safety of personnel, equipment, facilities, and the public during and from the performance of operations.

Safety Critical. Term describing any condition, event, operation, process, equipment, or system that could cause or lead to severe injury, major damage, or mission failure if performed or built improperly, or allowed to remain uncorrected.

Safety Critical Function. A system, equipment, or facility function or process that, by not performing as intended, causes a safety critical condition or event.

Safety Critical Item. Single failure point or other element or item in a life or mission-essential application that, as determined by the results of failure modes and effects analysis or other safety analysis, is essential to the safe functioning of a system or subsystem.

Safety Device. A device that is part of a system, subsystem, or equipment that will reduce or make controllable hazards which cannot be otherwise eliminated through design selection.

Safety Evaluation Report (SER). A safety report prepared by the INSRP detailing the INSRP's assessment of the nuclear safety of a particular source or system based upon INSRP's evaluation of the program-supplied SAR and other pertinent data.

Safety Margin. Difference between as-built factor of safety and the ratio of actual operating conditions to the maximum operating conditions specified during design.

Safety Oversight. Maintaining functional awareness of program activities on a real-time basis to ensure risk acceptability.

Safety Program. The implementation of a formal comprehensive set of safety procedures, tasks, and activities to meet safety requirements, goals, and objectives.

Safeing. Sequence of events necessary to reconfigure a system to a lower level of risk.

System Safety and Risk Management Assistance Committee (SSARMAC). This committee, established by letter from the Director, Safety and Risk Management Division, in August 1997, is chartered to (1) enhance the development, review, and reengineering of system safety and risk management policies; (2) facilitate the identification and prioritization of system safety research and technology activities; (3) foster the exchange of system safety and risk management experiences and successes within NASA; and (4) serve as a forum for discussion of issues. One member or members (if separate system safety and risk management representatives are needed) will be appointed from each Center and the Jet Propulsion Laboratory.

Serious. When used with "hazard," "violation," or "condition," denotes there is a substantial probability that death or serious physical harm could result.

Significant Root Cause. The major anomalous event immediately preceding a mishap in the absence of which the mishap would not have occurred.

Single Failure Point. An independent element of a system (hardware, software, or human) the failure of which would result in loss of objectives, hardware, or crew.

Sneak Circuit. Unintended system design condition in electrical circuits or software source code not caused by a failure, which can inhibit wanted functions or cause unintended functions to occur through a stimulus, path, or a response relationship.

Sneak Circuit Analysis (SCA). A technique by which the system safety engineer can identify latent conditions (e.g., electrical, hydraulic, or other control systems) not caused by component failure that can inhibit desired functions or cause undesired functions to occur.

Software Hazard Analysis. Identification and verification of adequate software controls and inhibits; and the identification, analysis, and elimination of discrepancies relating to safety critical command and control functions.

Software Safety Critical. Software operations that, if not performed, performed out of sequence, or performed incorrectly, could directly or indirectly cause or allow a hazardous condition to exist.

Supervisor-in-Charge of the Workplace (Establishment). A building manager, building operator, facility manager, facility operations manager (FOM), facility engineering head, or other designated official who normally initiates requests for repairs or maintenance for a particular building of a facility or area within a facility.

System Concept Review (SCR). A review conducted when sufficient system functional requirements have been established. Safety verifies the adequacy of the system requirements definitions, ensures designers are acquainted with interface technical requirements, reviews design approaches to be optimized and complete, and evaluates system interfaces for risks.

System Safety. Application of engineering and management principles, criteria, and techniques to optimize safety and reduce risks within the constraints of operational effectiveness, time, and cost throughout all phases of the system life cycle.

System Safety Manager (SSM). A designated management person who, qualified by training and/or experience, is responsible to ensure accomplishment of system safety tasks.

System Safety Review Panel (SSRP). A mechanism for enhancing the Space Shuttle Program (SSP) system safety management and engineering through informational interchanges, development of concepts to improve the SSP safety program, review of safety documentation, review of SSP integration and cargo integration, review of SSP element-level hazard identification and resolution activities, and recommendations to Level 2 management for hazard report disposition.

Users of Hazardous Material. Users are those personnel who open the incremental hazardous material shipping container, thereby exposing the material to mix, transfer, burn, freeze, pour, vent, react, dispose, or otherwise use or alter the material.

Vacuum System. An assembly of components under vacuum, including vessels, piping, valves, relief devices, pumps, expansion joints, gages, etc.

Vacuum Vessel. A vessel in which the internal pressure has been reduced to a level less than that of the surrounding atmosphere.

Validation. (1) An evaluation technique to support or corroborate safety requirements to ensure necessary functions are complete and traceable; or (2) the process of evaluating software at the end of the software development process to ensure compliance with software requirements.

Variance. Documented and approved permission to perform some act or operation contrary to established requirements.

Verification (Software). (1) The process of determining whether the products of a given phase of the software development cycle fulfill the requirements established during the previous phase (see also validation); or (2) formal proof of program correctness; or (3) the act of reviewing, inspecting, testing, checking, auditing, or otherwise establishing and documenting whether items, processes, services, or documents conform to specified requirements.

Waiver: A variance that authorizes departure from a specific safety requirement where a certain level of risk has been documented and accepted.

APPENDIX C. Safety Motivation and Awards Program

1. The following awards represent NASA`s primary means for recognizing outstanding safety performance:

a. NASA Honor Awards. These awards are approved by the Administrator and represent the highest honorary recognition bestowed by NASA. Government and non-Government personnel making significant safety contributions may be nominated for these awards following the guidelines provided in NPG 3451.1, "The NASA Awards and Recognition Program."

b. NASA Space Flight Awareness, Flight Safety Award. This award is managed by the Space Flight Safety Panel in accordance with NPC 1152.66, "NASA Space Flight Safety Panel." It is bestowed in recognition of contributions to space flight safety made through design, device, or practice. The purpose of the award is to acknowledge the individuals whose personal efforts, above and beyond their job commitment, result in significant, direct contributions to space flight safety. The award is given to both individuals and groups. Every Government and industry employee supporting NASA`s human space flight programs is eligible for this award.

c. Center Safety Awards. The majority of NASA safety awards are issued at the local level as part of each Center`s overall safety effort. Safety programs at NASA Centers shall include an awards program, designed in accordance with this document, to recognize and encourage safety in all operations.

2. NASA safety awards shall be properly designed to motivate and maintain safe behavior. The following principles shall be considered when developing safety awards:

a. The manner in which the award is presented is important. The award should be presented publicly to effectively satisfy the individual`s/group`s need for recognition and thereby provide an incentive for other personnel.

b. Any award based on competition must be carefully designed to avoid possible negative aspects. (For example, employees involved in a competition to reduce on-the job injuries have been known to avoid seeking medical attention for an injury so that it would not be reported.)

c. The safety awards program should be part of the participating safety program and include all personnel.

d. The responsible NASA safety organization shall clearly define the purpose of each award, those who are eligible, and the criteria for selection.

e. Award presentations and the safety contributions made by award recipients shall be sufficiently publicized to heighten employee safety awareness and to encourage active employee participation in all efforts designed to improve safety performance.

f. Awards shall be granted on the basis of merit without regard to age, color, handicap, marital status, national origin, politics, participation or non-participation in a labor organization, race, religion, or sex.

g. NASA awards for safety excellence shall be granted based on specific published criteria. Nominations shall be evaluated against the individual awards criteria and not against any unwritten standards or interpretations.

3. In conjunction with safety awards, NASA safety programs may distribute items of minimal value to individuals as a means of promoting safe work practices and heightening safety awareness. The following apply to the purchase and distribution of safety promotional items:

a. Procurements made with Federally-appropriated funds are subject to the rulings of the General Accounting Office (GAO). Safety promotional items usually are interpreted by GAO as personal gifts, and therefore have not been allowed. It is recommended that non-appropriated funds be used for the procurement of safety promotional items whenever possible.

b. Safety promotional items shall be distributed for valid reason and shall not be given with such frequency that they lose meaning.

c. All items shall be clearly identified as NASA safety program items via printed markings and/or safety logos.

APPENDIX D: Analysis Techniques

The purpose of safety analysis is to provide a means to systematically and objectively identify hazards, determine their risk level, and provide the mechanism for their elimination or control. Safety analysis is an iterative process that begins with the concept and extends throughout the life cycle including disposal.

1. Functions supported by the analysis include the following:

a. Providing the foundation for the development of safety criteria and requirements.

b. Determining whether and how the safety criteria and requirements provided to engineering have been included in the design.

c. Determining whether the safety criteria and requirements created for design and operations have provided an acceptable level of risk for the system.

d. Providing part of the means for imposing pre-established safety goals.

e. Providing a means for demonstrating that safety goals have been met.

The extent and depth of analysis required to meet these five functions will be determined by system complexity and loss potential.

2. During the hazard identification process, it is essential to remain nonjudgmental about the associated probability, severity, and corrective actions. Once identified, hazards shall then be ranked by severity, probability of occurrence, and program impact (risk assessment). Sufficient analysis must be performed to assess the likelihood of occurrence (usually qualitative for early assessments) for each identified undesired event.

3. There are several types of analyses necessary to identify all the hazards; some are specialized and others, as designs mature, build on previously accomplished analyses.

4. Analyses such as the ones described below shall be employed to the extent and depth determined by the system safety manager as necessary to fully assess the risk to personnel, equipment, and property.

a. Preliminary Hazard Analysis (PHA). In many ways the PHA is the most important of the safety analyses because it is the foundation on which the rest of the safety analyses and the system safety tasks are built. It documents which generic hazards are associated with the design and operational concept. This provides the initial framework for a master listing (or hazard catalog) of hazards and associated risks that require tracking and resolution during the course of the program design and development. The PHA also may be used to identify safety-critical systems that will require the application of failure modes and effects analysis and further hazard analysis during the design phases.

b. The program shall require and document a PHA to obtain an initial listing of risk factors for a system concept. The PHA effort shall be started during the concept exploration phase or earliest life cycle phases of the program. A PHA considers hardware, software, and the operational concepts. Hazards identified in the PHA will be assessed for risk based on the best available data, including mishap data from similar systems, other lessons learned, and hazards associated with the proposed design or function. Mishap and lessons learned information are available in the Incident Reporting Information System (IRIS) and the Lessons Learned Information System (LLIS). The risk assessment developed from the PHA will be used to ensure safety considerations are included in tradeoff studies of design alternatives; development of safety requirements for program and design specifications, including software for safety-critical monitor and control; and definition of operational conditions and constraints.

c. Extensions and refinements of the PHA should coincide with the development of the design after the conceptual phase. A system generally consists of several discrete subsystems that should be individually analyzed in subsystem hazard analysis (SSHA). The results of the SSHA`s in turn feed into the SHA, which will integrate its subsystems and identify hazards that cross the subsystem interfaces. The number of systems and subsystems in a program is a function of the complexity of individual projects and will be determined by the program. In relatively simple programs, the SHA may also serve as the integrated hazard analysis (IHA) if it also addresses risks. The hazard listing in the safety assessment report (SAR) must be updated to indicate the closure of hazards and newly identified hazards. The SHA should be completed coincidentally with the critical design review (CDR).

d. Operating and Support Hazard Analysis (O&SHA). The O&SHA is performed primarily to identify and evaluate the hazards associated with the use of environment, personnel interface, procedures including automated command and control, and supporting facilities/equipment involved in the operation of a system/element. "Operation" for the purposes of this appendix may include, but is not limited to, activities such as testing, installation, maintenance, transportation, contingency operations, and others. This analysis considers the planned system configuration or state at each phase of activity, the facility interfaces, the planned environments (or their ranges), the supporting tools or other equipment specified for use, operational/task sequence, concurrent task effects and limitations, biotechnological factors, regulatory or specified personnel safety and health requirements, and the potential for unplanned events including hazards introduced by human errors (see paragraph g., Human Factor Engineering Analysis). The O&SHA shall identify the safety requirements (i.e., constraints, limitations, conditions) to eliminate hazards or to reduce the associated risk to a level that is acceptable under either regulatory or specified criteria. An O&SHA is also used to validate design safety by verifying that the system will perform as expected if the operator correctly performs each step of approved procedures. The O&SHA should be updated when any system design or operational changes are included to ensure any needed hazard control changes.

e. Integrated Hazard Analysis (IHA). A complex program will require analysis of the widely divergent elements or system designs that must be assembled and operated together. The IHA ensures that hazards, along with their causes and controls, that cross element, system, or operational interfaces are identified, assessed, and resolved to an acceptable level. For purposes of the IHA, integration should be considered an element of a system. This analysis should start with an integrated PHA and progress in parallel with other system or element safety analyses. This analysis is broader in scope in that it looks at an entire program rather than a portion of it. The IHA process should act as a conduit to facilitate notification of affected systems or elements when a hazard, cause, or control crosses an interface.

f. System Hazard Analysis (SHA). An SHA is a top-level hazards analysis to verify system compliance with safety requirements contained in system specifications and other applicable documents. It is used to identify previously unidentified hazards associated with the subsystem interfaces and system functional faults; assess the risk associated with the total system design, including software, and specifically of the subsystem interfaces; and recommend actions necessary to eliminate identified hazards and/or control their associated risk to acceptable levels.

g. Software Safety Analysis (SSA). A PHA identifies the safety-critical characteristics of a system. If the PHA identifies hazards that are functions assigned to an inhibit or software control of the system undergoing analysis, that software must undergo safety analysis. When a system software component has been identified as safety-critical, the software safety analysis process shall begin with the development of safety objectives. The safety objectives shall be derived by examining the properties of each critical function and expressing them in terms of system responses and consequences. These objectives shall be unique to each safety-critical software component. Software safety analysis verifies that the software contains no errors or deficiencies that could contribute to risks to people or property. Software safety analysis consists of four phases: requirements analysis, design analysis, code analysis, and testing. The safety analysis effort shall begin with the requirements analysis phase of software development. This will ensure that all safety-critical requirements are specified and designed into the final software product. This approach to software safety analysis will provide optimum software safety with the least impact to the cost and schedule of the software development effort. The analysis techniques must be structured to allow for revisions and updates as the system matures.

h. Subsystem Hazard Analysis (SSHA). An SSHA is a hazards analysis to verify subsystem compliance with safety requirements contained in subsystem specifications and other applicable documents. It is used to identify previously unidentified hazards associated with the design of subsystems including component failure modes, critical human error inputs, and hazards resulting from functional relationships between components and equipment comprising each subsystem, and to recommend actions necessary to eliminate identified hazards or control their associated risk to acceptable levels.

i. Human Factors Engineering Analysis. The program manager should apply human factors engineering analysis for human error avoidance during the development and acquisition of NASA systems, equipment, software, and facilities to achieve the effective integration of the human element into system performance. A human error avoidance effort shall be provided to develop or improve the crew-equipment/software interface; to achieve required effectiveness of human performance during system operation and maintenance; to make economical use of personnel resources, skills, and training; and to minimize the possibility of human-induced error. Two-fault tolerance is required for all human errors that could result in a catastrophic hazard. The human error avoidance assessment shall be an integral part of the PHA, SHA, SSHA, and O&SHA as required. Human engineering principles shall be applied to the design to eliminate or mitigate potential hazards associated with the man-machine interface. Extensions or transformations of the results of system safety efforts for use in the human error avoidance task are not considered duplication.

5. The following tools and techniques shall be selected as appropriate to help identify the primary causes of an identified hazard:

a. Failure Modes and Effects Analysis (FMEA)/Critical Items List (CIL). The FMEA is usually performed by the assigned reliability office to identify critical items in hardware. The FMEA should be used to assist safety personnel to perform hazard analyses and supplement, not replace, hazard analyses. Safety personnel can use the FMEA to help verify that all safety-critical hardware has been addressed in the hazard analyses. The FMEA in hardware systems is an important technique for evaluating the design and documenting the review process. All credible failure modes and their resultant effects at the component and system levels are identified and documented. Items which meet defined criteria are identified as critical items and are placed on the CIL. Each entry of the CIL is then evaluated to see if design changes can be implemented so the item can be deleted from the CIL. Items that cannot be deleted from the CIL must be accepted by the program/project based on the rationale for acceptance of the identified risk. The analysis follows a well-defined sequence of steps that encompasses (1) failure mode, (2) failure effects, (3) causes, (4) detectability, (5) corrective or preventative actions, and (6) rationale for acceptance.

b. Fault Tree Analysis (FTA). The FTA is a technique by which the system safety engineer can rigorously evaluate specific hazardous events. It is a type of logic tree that is developed by deductive logic from a top undesired event to all subevents that must occur to cause it. It is primarily used as a qualitative technique for studying hazardous events in systems, subsystems, components, or operations involving command paths. The FTA can be used to verify that the FMEA has identified all Critical Single Failure Points (CSFP`s) consistent with the Top Event hazardous condition. It also can be used for quantitatively evaluating the probability of the top event and all subevent occurrences when sufficient and accurate data are available. Quantitative analyses shall be performed only when it is reasonably certain that the data for part/component failures and human errors for the operational environment exist. The individual failure paths or minimal cut sets shall be generated and evaluated for acceptable risk.

c. Sneak Circuit Analysis (SCA). The SCA is a technique by which the system safety engineer can identify latent conditions (e.g. electrical, hydraulic, or other control systems) not caused by component failure that can inhibit desired functions or cause undesired functions to occur. A full-scale SCA may not be feasible depending on project constraints. Therefore, an SCA can be done on catastrophic hazards as identified by system-level FMEA or hazards analyses.

d. Event Tree Analysis (ETA). The ETA is a technique by which the system safety engineer can evaluate possible outcomes using a type of logic tree. It is an inductive logic method for identifying the various possible outcomes of a given initiating event.

Appendix E. Example Hazard Report

1. Hazard reports (HR`s) for safety hazards shall be written prior to each major milestone to document residual risks identified in the hazard analysis process against program requirements. The HR is a tool by which residual risks are identified in such a manner that each level of technical management in a program can evaluate the risks and formally accept them based on documented rationale. HR`s will be updated to reflect program changes and modifications that affect the identified risk.

2. Specific data requirements will vary among programs, but the HR data elements within a program will be standardized. The following is recommended as a minimum data element set. This process is not intended to apply to those Federally-mandated requirements, e.g., OSHA, DOT, FAA, etc.

a. Report Number. Each HR will be given a unique alpha-numeric number that identifies the system/subsystem for which it is written. Provision will be made for a revision letter and Document Control Number (DCN).

b. Date. Date of preparation/revision of the HR.

c. Status.

> Closed: Corrective action to eliminate or control the hazard has been implemented or scheduled for implementation before the effectivity identified in the HR. Program management accepts the risk pending completion of corrective action and verification. Baselining (written approval of the HR within the configuration management system) is required to approve an HR as closed.
>
> Open: An HR status is open when corrective action to eliminate or control the hazard has not been completed and the corrective action is not scheduled to be performed.

d. Title. Provide a short descriptive (not generic) title for the hazard.

e. System. Identify the system/subsystem/component at the level at which the hazard is being written.

f. Effectivity. This element helps to narrow and define the applicability of the hazard. It will vary by type of program and could be specific to a test, flight, or vehicle. It could also be applicable to a series (or fleet) of tests, vehicles, or flights.

g. Operation Phase. A discrete period defined by the program for tests or operations during which the hazard could occur. A hazard could occur during one or more phases such as pre-launch, stage one, on-orbit, recovery, etc.

h. Description of the Hazardous Condition. Describe the condition which can/will lead to loss of flight or ground personnel, loss of safety-critical system, loss of life or injury to the public, loss of equipment/flight vehicle, or loss of public property. The hazardous condition shall be described in terms of one or more generic hazards, such as fire/explosion, impact, etc. The description should explicitly specify the equipment involved, e.g., "Impact between separating upper stages could result in loss of trajectory control for final stage."

i. Risk Acceptance Rationale. Provide a brief summary of the technical rationale for accepting the residual risks identified in the HR.

j. Submittal Signatures. The specific signatures required on a HR will vary with the size of the program and whether it is contracted or performed in-house at NASA. The following signatures should be required as a minimum:

(1) Originating activity design engineer.

(2) Originating activity safety engineering manager.

(3) Assigned NASA Field Installation system/subsystem engineer.

(4) Assigned NASA Field Installation safety engineer.

k. Risk Assessment Section. The risk assessment section of the HR comprises several linked data elements. These are: cause(s), effect(s), safety requirements, control(s), verification(s), classification, severity, and likelihood of occurrence. While an HR is generated to address one hazardous condition, the condition may result from several related or mutually exclusive hazard causes. In turn, each cause could result in multiple effects and multiple safety requirements. Multiple controls may be required to control the cause, the effect, or both, and each control may use several verification methods to assure the control is in place. Each discrete effect, safety requirement, and control will be hard-linked to its cause, and each discrete verification method will be hard-linked to its control. Based on the data, the risk (severity and likelihood of occurrence) will be assessed for each cause, and the cause will be assigned a classification based on the risk. For each hazard cause, the worst case effect will determine the severity level to be assigned. For each hazard cause, the controls that are in place are assessed to determine the likelihood of occurrence from the program risk assessment matrix when the likelihood of occurrence has been derived using probabilistic methods, the numerical probability will be used. Eliminated hazard cause will not be documented in this part of the HR, but should be included in background data to maintain visibility of improvements made during the hazard analysis and reporting process. The assigned reference number of the eliminated cause and linked data will not be deleted, but will be annotated as "Eliminated."

l. Causes. Describe the unsafe acts or conditions that may lead to the hazardous event. Hazard causes shall be identified down to the level at which controls are to be applied and shall consider environments, hardware failures, secondary failures/conditions, software errors, procedural errors, operationally induced external and internal failures, and human errors/limitations. In addition to the program engineering and operations data, generation of the causes and linked data should consider waivers and deviations with safety impact; test, processing, and operational problems/anomalies; alerts and, trending data; and interface/integrated hours.

m. Effect(s). Describe the potential worst case outcomes of the hazard cause.

n. Requirement(s). Provide narrative descriptions of the requirement(s) that define criteria to be met when controlling the hazard. In addition to listing safety requirements used to control the hazard, provide other requirements used to control each cause and effect. The reference must include document number and title. The lowest level requirements should be used as primary references and the higher level requirements as secondary priority.

o. Control(s). Provide narrative description(s) of the appropriate design, safety devices, alarm/caution and warning devices, or special automatic/manual procedures used to control the hazard. Documentation references by document number and title are required for each control.

p. Verification(s). Identify the method(s) used to verify the hazard control(s). Verification methods include analyses, tests, inspections, and operations and maintenance requirements. Verification reference documents will be identified by number and title. Procedures and/or specifications will be referenced to document verification.

q. Severity. Describe severity for each cause by assessing the most severe effect and documenting it as catastrophic, critical, moderate, or negligible (see Chapter 3 for more information).

r. Likelihood of Occurrence. This part of the HR is completed for each cause.

(1) When probabilistic risk assessment methods are used, list the numerical probability of occurrence for this cause.

(2) When qualitative risk assessment methods are used, the controls that are in place must be assessed and documented for likelihood of occurrence in accordance with the defined program risk assessment matrix. The following are recommended probability definitions (see Chapter 3 for more information).

A - Likely to occur immediately. ($X > 10^{-1}$)
B - Probably will occur in time. ($10^{-1} \geq X > 10^{-2}$)
C - May occur in time. ($10^{-2} \geq X > 10^{-3}$)
D - Unlikely to occur. ($10^{-3} \geq X > 10^{-6}$)
E - Improbable to occur. ($10^{-6} \geq X$)

s. Classification. Each hazard cause will be assigned a classification of controlled, accepted risk, or (extremely rare) unacceptable risk. A risk of the latter magnitude should never reach the HR baseline stage, but provision is made for its use when the HR is used for information reporting. See the Glossary for definition of the classification terms.

3. Overall HR Risk Assessment and Closure.

a. Quantitative.

(1) The quantitative approach involves the use of probabilistic risk assessment methods to compute the risk probability for the hazard.

(2) A numerical probability alone may not be sufficient to make a closure determination. Extremely low probabilities are easy to call, but higher probabilities may require further controls. The program shall devise a method/policy for determining closure.

b. Qualitative.

(1) When qualitative risk assessment methods are used, a risk picture, using a program-defined risk

assessment matrix, shall be included as part of the HR and presented to program management as a check to ensure the proper severity and likelihood of occurrence. An example of the risk assessment matrix is shown in figure 3-1. This matrix uses the severity and suggested likelihood of occurrence definitions from Chapter 3. The risk matrix will be completed by documenting each hazard cause severity and likelihood of occurrence in the appropriate block. The controls are considered to be in place when the matrix is marked.

(2) Hazard closure classifications will be either eliminated, accepted as is, or controlled. Unacceptable risks require reduction prior to HR baselining and are a constraint to tests and operations.

4. Interfaces. Identify system interface(s) that are affected by and cause hazard conditions within the report, including facilities, ground support equipment (GSE), and other parts of the program.

5. References. Include pertinent reference information to other program documentation that affect, and are affected by, data elements within the HR. These include, but are not limited to, FMEA/CIL, requirement and specification documents, procedures, test and operational limitation and criteria rules, and flight rules.

6. Background/Remarks. Include information that increases understanding of the hazard, describes changes to the hazard, and identifies supportive documentation, etc. Use it to document the chronology of major events associated with the hazard, including related flight history, test and check-out, failure summaries, changes to the design or operation, etc.

7. Status of Open Work. Identify open work, responsible agency, action required, and the due date. Completion due dates will be supplied only for open work that is a constraint to a critical milestone in the program.

8. Preparing Engineer and Date. Identify the preparing engineer/analyst and the date the HR was prepared.

Appendix F. Sample Training Schedule

Employee Training Schedule 1999 - 2000	**Year - Quarter**							
Type Employee Training Class	**99-1**	**99-2**	**99-3**	**99-4**	**00-1**	**00-2**	**00-3**	**00-4**
New Employee Orientation	X	X	X	X	X	X	X	X

All Employees								
Safety Tips in Newsletter	X	X	X	X	X	X	X	X
Fire Prevention Week Information				X				X
Management								
Management Safety Responsibility Handout		X				X		
OSHA Program Orientation for Managers	X		X		X		X	
Supervisors								
Office Safety and Fire Protection for Office Managers		X		X		X		X
Employee Representatives								
Safety and Health Information Brochure	X		X		X		X	
Laboratory Workers								
Laboratory Safety Course		X		X		X		X
Motor Vehicle Operators								
Safe Drivers Course	X		X		X		X	
Material Handlers								
Lift Truck Operations Safety and Safe Back Course		X		X		X		X

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Appendix G. Activity and Fissile Material Limits Basic A_1 /A_2 Values

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1. Values of A_1 and A_2 for individual radionuclides, which are the basis for many activity limits elsewhere in this NPG, are given in Table I.

DETERMINATION OF A_1 AND A_2

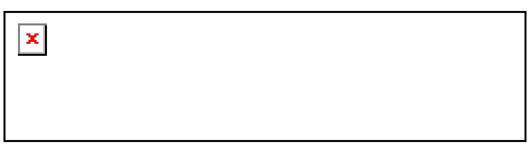
2. For individual radionuclides whose identities are known, but which are not listed in Table I, the determination of the values of A_1 and A_2 shall require competent authority approval or, for international transport, multilateral approval. Alternatively, the values of A_1 and A_2 in Table II may be used without obtaining competent authority approval.

3. In the calculations of A_1 and A_2 for a radionuclide not in Table I, a single radioactive decay chain in which the radionuclides are present in their naturally occurring proportions and in which no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide shall be considered as a single radionuclide, and the activity to be taken into account and the A_1 or A_2 value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and such daughter nuclides shall be considered as mixtures of different nuclides.

4. For mixtures of radionuclides whose identities and respective activities are known, the following conditions shall apply:

(a) For special form radioactive material:

(b) For other forms of radioactive material:



where B(i) is the activity of radionuclide i and $A_1(i)$ and $A_2(i)$ are the A_1 and A_2 values for radionuclide i, respectively.

TABLE I. A_1 and A_2 VALUES FOR RADIONUCLIDES

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{225}Ac (b)*	Actinium (89)	0.6	10	1 x 10^{-2} 2 x 10^{-1}	10
^{227}Ac		40	1000	2 x 10^{-5} 5 x 10^{-4}	

^{228}Ac		0.6	10	0.4	
^{105}Ag	Silver (47)	2	50	2	50
$^{108}Ag^{m}$		0.6	10	0.6	10
$^{110}Ag^{m}$		0.4	10	0.4	10
^{111}Ag		0.6	10	0.6	10
^{26}Al	Aluminum (13)	0.4	10	0.4	10
^{241}Am	Americium (95)	2	50	$2 \times 10^{-4}5 \times 10^{-3}$	
$^{242}Am^{m}$		2	50	$2 \times 10^{-4}5 \times 10^{-3}$	
^{243}Am		2	50	$2 \times 10^{-4}5 \times 10^{-3}$	
^{37}Ar	Argon (18)	40	1000	40	1000
^{39}Ar		20	500	20	500
^{41}Ar		0.6	10	0.6	10
^{42}Ar (b)		0.2	5	0.2	5
^{72}As	Arsenic(33)	0.2	5	0.2	5
^{73}As		40	1000	40	1000
^{74}As		1	20	0.5	10
^{76}As		0.2	5	0.2	5
^{77}As		20	500	0.5	10
^{211}At	Astatine (85)	30	800	2	50

* Note: (b) indicates a footnote at the end of Table I: this form is used to avoid confusion with the superscript m.

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{193}Au	Gold (79)	6	100	6	100
^{194}Au		1	20	1	20
^{195}Au		10	200	10	200
^{196}Au		2	50	2	50
^{198}Au		3	80	0.5	10
^{199}Au		10	200	0.9	20
^{131}Ba	Barium (56)	2	50	2	50
$^{133}Ba^{m}$		10	200	0.9	20
^{133}Ba		3	80	3	80
^{140}Ba (b)		0.4	10	0.4	10
^{7}Be	Beryllium (4)	20	500	20	500
^{10}Be		20	500	0.5	10
	Bismuth (83)	0.6	10	0.6	10

^{205}Bi		0.3	8	0.3	8
^{206}Bi		0.7	10	0.7	10
^{207}Bi		0.3	8	3 x 10^{-2}8 x 10^{-1}	
^{210}Bi^{m} (b)		0.6	10	0.5	10
^{210}Bi		0.3	8	0.3	8
^{212}Bi (b)				.	
^{247}Bk	Berkelium (97)	2	50	2 x 10^{-4}5 x 10^{-3}	
^{249}Bk		40	1000	8 x 10^{-2} 2	
^{76}Br	Bromine (35)	0.3	8	0.3	8
^{77}Br		3	80	3	80
^{82}Br		0.4	10	0.4	10
^{11}C	Carbon (6)	1	20	0.5	10
^{14}C		40	1000	2	50
^{41}Ca		40	1000	40	1000
^{45}Ca	Calcium (20)	40	1000	0.9	20
^{47}Ca		0.9	20	0.5	10
^{109}Cd	Cadmium (48)	40	1000	1	20
^{113}Cd^{m}		20	500	9 x 10^{-2} 2	
^{115}Cd^{m}		0.3	8	0.3	8
^{115}Cd		4	100	0.5	10
^{139}Ce		6	100	6	100
^{141}Ce	Cerium (58)	10	200	0.5	10
^{143}Ce		0.6	10	0.5	10
^{144}Ce (b)		0.2	5	0.2	5

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{248}Cf	Californium (98)	30	800	3 x 10^{-3}8 x 10^{-2}	
^{249}Cf		2	50	2 x 10^{-4}5 x 10^{-3}	
^{250}Cf		5	100	5 x 10^{-4}1 x l0^{-2}	
^{251}Cf		2	50	2 x 10^{-4}5 x 10^{-3}	
^{252}Cf		0.1	2	1 x 10^{-3}2 x 10^{-2}	
^{253}Cf		40	1000	6 x 10^{-2} 1	
^{254}Cf		3 x 10^{-3}8 x 10^{-2}	6 x 10^{-4}1 x 10^{-2}		
^{36}Cl	Chlorine (17)	20	500	0.5	10
^{38}Cl		0.2	5	0.2	5
^{240}Cm	Curium (96)	40	1000	2 x 10^{-2}5 x 10^{-1}	
^{241}Cm		2	50	0.9	20

^{242}Cm		40	1000	1×10^{-2} 2×10^{-1}	
^{243}Cm		3	80	3×10^{-4} 8×10^{-3}	
^{244}Cm		4	100	4×10^{-4} 1×10^{-2}	
^{245}Cm		2	50	2×10^{-4} 5×10^{-3}	
^{246}Cm		2	50	2×10^{-4} 5×10^{-3}	
^{247}Cm				2×10^{-4} 5×10^{-3}	
^{248}Cm		4×10^{-2} 1	5×10^{-5}	1×10^{-3}	
^{55}Co	Cobalt (27)	0.5	10	0.5	10
^{56}Co		0.3	8	0.3	8
^{57}Co		8	200	8	200
^{58}Co^{m}		40	1000	40	1000
^{58}Co		1	20	1	20
^{60}Co		0.4	10	0.4	10

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{51}Cr	Chromium (24)	30	800	30	800
^{129}Cs	Caesium (55)	4	100	4	100
^{131}Cs		40	1000	40	1000
^{132}Cs		1	20	1	20
^{134}Cs^{m}		40	1000	9	200
^{134}Cs		0.6	10	0.5	10
^{135}Cs		40	1000	0.9	20
^{136}Cs		0.5	10	0.5	10
^{137}Cs (b)		2	50	0.5	10
^{64}Cu	Copper (29)	5	100	0.9	20
^{67}Cu		9	200	0.9	20
^{159}Dy	Dysprosium (66)	20	500	20	500
^{165}Dy		0.6	10	0.5	10
^{166}Dy (b)		0.3	8	0.3	8
^{169}Er	Erbium (68)	40	1000	0.9	20
^{171}Er		0.6	10	0.5	10
^{147}Eu	Europium (63)	2	50	2	50
^{148}Eu		0.5	10	0.5	10
^{149}Eu		20	500	20	500
^{150}Eu		0.7	10	0.7	10
^{152}Eu^{m}		0.6	10	0.6	10
		0.9	20	0.9	20

^{153}Eu ^{154}Eu ^{155}Eu ^{156}Eu		0.8 20 0.6	20 500 10	0.8 2 0.5	10 50 10
^{18}F	Fluorine (9)	1	20	0.5	10
^{52}Fe (b) ^{55}Fe ^{59}Fe ^{60}Fe	Iron (26)	0.2 40 0.8 40	5 1000 20 1000	0.2 40 0.8 0.2	5 1000 20 5

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{67}Ga ^{68}Ga ^{72}Ga	Gallium (31)	6 0.3 0.4	100 8 10	6 0.3 0.4	100 8 10
^{146}Gd (b) ^{148}Gd ^{153}Gd ^{159}Gd	Gadolinium (64)	0.4 3 10 4	10 80 200 100	0.4 3×10^{-4} 8×10^{-3} 5 0.5	10 100 10
^{68}Ge (b) ^{71}Ge ^{77}Ge	Germanium (32)	0.3 40 0.3	8 1000 8	0.3 40 0.3	8 1000 8
^{172}Hf (b) ^{175}Hf ^{18l}Hf ^{182}Hf	Hafnium (72)	0.5 3 2 4	10 80 50 100	0.3 3 0.9 3×10^{-2} 8×10^{-1}	8 80 20
^{194}Hg (b) ^{195}Hg^{m} ^{197}Hg^{m} ^{197}Hg ^{203}Hg	Mercury (80)	1 5 10 10 4	20 100 200 200 100	1 5 0.9 10 0.9	20 100 20 200 20
^{163}Ho ^{166}Ho^{m} ^{166}Ho	Holmium (67)	40 0.6 0.3	1000 10 8	40 0.3 0.3	1000 8 8
^{123}I ^{124}I ^{125}I ^{126}I	Iodine (53)	6 0.9 20 2	100 20 500 50	6 0.9 2 0.9	100 20 50 20

^{129}I		Unlimited	80	Unlimited	10
^{131}I		3	10	0.5	10
^{132}I		0.4	10	0.4	10
^{133}I		0.6	8	0.5	8
^{134}I		0.3	10	0.3	10
^{135}I		0.6		0.5	

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{111}In	Indium (49)	2	50	2	50
$^{113}In^m$		4	100	4	100
$^{114}In^m$ (b)		0.3	8	0.3	8
$^{115}In^m$		6	100	0.9	20
^{189}Ir	Iridium (77)	10	200	10	200
^{190}Ir		0.7	10	0.7	10
^{192}Ir		1	20	0.5	10
$^{193}Ir^m$		10	200	10	200
^{194}Ir		0.2	5	0.2	5
^{40}K	Potassium (19)	0.6	10	0.6	10
^{42}K		0.2	5	0.2	5
^{43}K		1	20	0.5	10
^{8l}Kr	Krypton (36)	40	1000	40	1000
$^{85}Kr^m$		6	100	6	100
^{85}Kr		20	500	10	200
^{87}Kr		0.2	5	0.2	5
^{137}La	Lanthanum (57)	40	1000	2	50
^{140}La		0.4	10	0.4	10
LSA	Low specific	activity material	(see paragraph.	131 of Parent	Document)
^{172}Lu	Lutetium (71)	0.5	10	0.5	10
^{173}Lu		8	200	8	200
$^{174}Lu^m$		20	500	8	200
^{174}Lu		8	200	4	100
^{177}Lu		30	800	0.9	20
MFP	For mixed fission	products, use	formula for	mixtures or	Table II
^{28}Mg (b)	Magnesium (12)	0.2	5	0.2	5
^{52}Mn	Manganese (25)	0.3	8	0.3	8
^{53}Mn		Unlimited		Unlimited	
^{54}Mn		1	20	1	20
		0.2	5	0.2	5

^{56}Mn

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{93}Mo	Molybdenum (42)	40	1000	7	100
^{99}Mo		0.6	10	0.5	10
^{13}N	Nitrogen (7)	0.6	10	0.5	10
^{22}Na	Sodium (11)	0.5	10	0.5	10
^{24}Na		0.2	5	0.2	5
$^{92}Nb^m$	Niobium (41)	0.7	10	0.7	10
$^{93}Nb^m$		40	1000	6	10
^{94}Nb		0.6	10	0.6	10
^{95}Nb		1	20	1	20
^{97}Nb		0.6	10	0.5	10
^{147}Nd	Neodymium (60)	4	100	0.5	10
^{149}Nd		0.36	10	0.5	10
^{59}Ni	Nickel (28)	40	1000	40	1000
^{63}Ni		40	1000	30	800
^{65}Ni		0.3	8	0.3	8
^{235}Np	Neptunium (93)	40	1000	40	1000
^{236}Np		7	100	1×10^{-3} 2×10^{-2}	
^{237}Np		2	50	2×10^{-4} 5×10^{-3}	
^{239}Np		6	100	0.5	10
^{185}Os	Osmium (76)	1	20	1	20
$^{191}Os^m$		40	1000	40	1000
^{191}Os		10	200	0.9	20
^{193}Os		0.6	10	0.5	10
^{194}Os (b)		0.2	5	0.2	5
^{32}P	Phosphorus (15)	0.3	8	0.3	8
^{33}P		40	1000	0.9	20
^{230}Pa		2	50	0.1	2
^{231}Pa	Protactinium (91)	0.6	10	6×10^{-5} 1×10^{-3}	20
^{233}Pa		5	100	0.9	

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{201}Pb	Lead (82)	1	20	1	20
^{202}Pb		40	1000	2	50
^{203}Pb		3	80	3	80
^{205}Pb		Unlimited		Unlimited	
^{210}Pb (b)		0.6	10	9×10^{-3} 2×10^{-1}	
^{212}Pb (b)		0.3	8	.3	8
^{103}Pd	Palladium (46)	40	1000	40	1000
^{107}Pd		Unlimited		Unlimited	10
^{109}Pd		0.6	10	0.5	
^{143}Pm	Promethium (61)	3	80	3	80
^{144}Pm		0.6	10	0.6	10
^{145}Pm		30	800	7	100
^{147}Pm		40	1000	0.9	20
$^{148}Pm^m$		0.5	10	0.5	10
^{149}Pm		0.6	10	0.5	10
^{151}Pm		3	80	0.5	10
^{208}Po	Polonium (84)	40	1000	2×10^{-2} 5×10^{-1}	
^{209}Po		40	1000	2×10^{-2} 5×10^{-1}	
^{210}Po		40	1000	2×10^{-2} 5×10^{-1}	
^{142}Pr	Praseodymium (59)	0.2	5	0.2	5
^{143}Pr		4	100	0.5	10
^{188}Pt (b)	Platinum (78)	0.6	10	0.6	10
^{191}Pt		3	80	3	80
$^{193}Pt^m$		40	1000	9	200
^{193}Pt		40	1000	40	1000
$^{195}Pt^m$		10	200	2	50
$^{197}Pt^m$		10	200	0.9	20
^{197}Pt		20	500	0.5	10

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{236}Pu	Plutonium (94)	7	100	7×10^{-4}	1×10^{-2}
^{237}Pu		20	500	20	500
^{238}Pu		2	50	2×10^{-4} 5×10^{-3}	
^{239}Pu		2	50	2×10^{-4} 5×10^{-3}	
^{240}Pu		2	50	2×10^{-4}	5×10^{-3}
		40	1000		

^{241}Pu		2	50	1×10^{-2}	2×10^{-1}
^{242}Pu		0.3	8	2×10^{-4}	5×10^{-3}
^{244}Pu (b)				2×10^{-4}	5×10^{-3}
^{223}Ra (b)	Radium (88)	0.6	10	3×10^{-2}	8×10^{-1}
^{224}Ra (b)		0.3	8	6×10^{-2}	1
^{225}Ra (b)		0.6	10	2×10^{-2}	5×10^{-1}
^{226}Ra (b)		0.3	8	2×10^{-2}	5×10^{-1}
^{228}Ra (b)		0.6	10	4×10^{-2}	1
^{81}Rb	Rubidium (37)	2	50	0.9	20
^{83}Rb		2	50	2	50
^{84}Rb		1	20	0.9	20
^{86}Rb		0.3	8	0.3	8
^{87}Rb		Unlimited		Unlimited	
Rb (natural)		Unlimited		Unlimited	
^{183}Re	Rhenium (75)	5	100	5	100
$^{184}Re^{m}$		3	80	3	80
^{184}Re		1	20	1	20
^{186}Re		4	100	0.5	10
^{187}Re		Unlimited		Unlimited	
^{188}Re		0.2	5	0.2	5
^{189}Re		4	100	0.5	10
Re (natural)		Unlimited		Unlimited	
^{99}Rh	Rhodium (45)	2	50	2	50
^{101}Rh		4	100	4	100
$^{102}Rh^{m}$		2	50	0.9	20
^{102}Rh		0.5	10	0.5	10
$^{103}Rh^{m}$		40	1000	40	1000
^{105}Rh		10	200	0.9	20
^{222}Rn (b)	Radon (86)	0.2	5	4×10^{-3}	1×10^{-1}

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{97}Ru	Ruthenium (44)	4	100	4	100
^{103}Ru		2	50	0.9	20
^{105}Ru		0.6	10	0.5	10

^{106}Ru (b)		0.2	5	0.2	5
^{35}S	Sulfur (16)	40	1000	2	50
^{122}Sb	Antimony (51)	0.3	8	0.3	8
^{124}Sb		0.6	10	0.5	10
^{125}Sb		2	50	0.9	20
^{126}Sb		0.4	10	0.4	10
^{44}Sc	Scandium (21)	0.5	10	0.5	10
^{46}Sc		0.5	10	0.5	10
^{47}Sc		9	200	0.9	20
^{48}Sc		0.3	8	0.3	8
SCO	Surface	contaminated	objects (see parag.	144 of Parent	Document)
^{75}Se	Selenium (34)	3	80	3	80
^{79}Se		40	1000	2	50
^{31}Si	Silicon (14)	0.6	10	0.5	10
^{32}Si		40	1000	0.2	5
^{145}Sm	Samarium (62)	20	500	20	500
^{147}Sm		Unlimited			Unlimited
^{151}Sm		40	1000	4	
^{153}Sm		4	100	0.5	100
					10
^{113}Sn (b)	Tin (50)	4	100	4	100
^{117}Sn^{m}		6	100	2	50
^{119}Sn^{m}		40	1000	40	1000
^{121}Sn^{m}		40	1000	0.9	20
^{125}Sn		0.6	10	0.5	10
^{126}Sn (b)		0.2	5	0.2	5
		0.3	8	0.3	8

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{82}Sr (b)	Strontium (38)	0.2	5	0.2	5
^{85}Sr^{m}		5	100	5	100
^{85}Sr		2	50	2	50
^{87}Sr^{m}		3	80	3	80
^{89}Sr		0.6	10	0.5	10
^{90}Sr (b)		0.2	5	0.1	2
^{91}Sr		0.3	8	0.3	8
		0.8	5	0.5	10

^{92}Sr (b)					
T (all forms)	Tritium (1)	40	1000	40	1000
^{178}Ta	Tantalum (73)	1	20	1	20
^{179}Ta		30	800	30	800
^{182}Ta		0.8	20	0.5	10
^{157}Tb	Terbium (65)	40	1000	10	200
^{158}Tb		1	20	0.7	10
^{160}Tb		0.9	20	0.5	10
^{95}Tc^{m}	Technetium (43)	2	50	2	50
^{96}Tc^{m} (b)		0.4	10	0.4	10
^{96}Tc		0.4	10	0.4	10
^{97}Tc^{m}		40	1000	40	1000
^{97}Tc		Unlimited		Unlimited	
^{98}Tc		0.7	10	0.7	10
^{99}Tc^{m}		8	200	8	20
^{99}Tc		40	1000	0.9	20
^{118}Te (b)	Tellurium (52)	0.2	5	0.2	5
^{121}Te^{m}		5	100	5	100
^{121}Te		2	50	2	50
^{123}Te^{m}		7	100	7	100
^{125}Te^{m}		30	800	9	200
^{127}Te^{m} (b)		20	500	0.5	10
^{127}Te		20	50	0.5	10
^{129}Te^{m} (b)		0.6	10	0.5	10
^{129}Te		0.6	10	0.5	10
^{131}Te^{m}		0.7	10	0.5	10
^{132}Te (b)		0.4	10	0.4	10

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq)	A_2 (Ci) (approx. [a])
				(approx. [a])	
^{227}Th	Thorium (90)	9	200	1×10^{-2}	2×10^{-1}
^{228}Th (b)		0.3	8	4×10^{-4}	1×10^{-2}
^{229}Th		0.3	8	3×10^{-5}	8×10^{-4}
^{230}Th		2	50	2×10^{-4}	5×10^{-3}
^{231}Th		40	1000	0.9	20
^{232}Th		Unlimited		Unlimited	
^{234}Th (b)		0.2	5	0.2	5

Th (natural)		Unlimited		Unlimited	
^{44}Ti (b)	Titanium (22)	0.5	10	0.2	5
^{200}Ti	Thallium (81)	0.8	20	0.8	20
^{201}Ti		10	200	10	200
^{202}Ti		2	50	2	50
^{204}Ti		4	100	0.5	10
^{167}Tm	Thulium (69)	7	100	7	100
^{168}Tm		0.8	20	0.8	20
^{170}Tm		4	100	0.5	10
^{171}Tm		40	1000	10	200
^{230}U ^{232}U ^{233}U ^{234}U ^{235}U ^{236}U U (natural) U (enriched 5% or less) U (enriched more than 5%) U (depleted)	Uranium (92)	40 3 10 10 Unlimited [c] 10 Unlimited Unlimited Unlimited [c] 10 Unlimited	1000 80 200 200 200 200	1×10^{-2} 2×10^{-1} 3×10^{-4} 8×10^{-3} 1×10^{-3} 2×10^{-2} 1×10^{-3} 2×10^{-2} Unlimited [c] 1×10^{-3} 2×10^{-2} Unlimited Unlimited [d] Unlimited [c,d] 1×10^{-3} [d] 2×10^{-2} Unlimited [d]	
^{48}V	Vanadium (23)	0.3	8	0.3	8
^{49}V		40	1000	40	1000

TABLE I. A_1 AND A_2 VALUES FOR RADIONUCLIDES (Continued)

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)	A_2 (TBq) (approx. [a])	A_2 (Ci) (approx. [a])
^{178}W(b)	Tungsten (74)	1	20	1	20
^{181}W		30	800	30	800
^{185}W		40	1000	0.9	20
^{187}W		2	50	0.2	10
^{188}W (b)		0.2	5		5
^{122}Xe (b)	Xenon (54)	0.2	5	0.2	5
^{123}Xe		0.2	5	0.2	5
^{127}Xe		4	100	4	100
^{131}Xe^{m}		40	1000	40	1000
^{133}Xe		20	500	20	500
^{135}Xe		4	100	4	100

^{87}Y	Yttrium (39)	2	50	2	50
^{88}Y		0.4	10	0.4	10
^{90}Y		0.2	5	0.2	5
$^{91}Y^m$		2	50	2	50
^{91}Y		0.3	8	0.3	8
^{92}Y		0.2	5	0.2	5
^{93}Y		0.2	5	0.2	5
^{169}Yb	Ytterbium (70)	3	80	3	80
^{175}Yb		30	800	0.9	20
^{65}Zn	Zinc (30)	2	50	2	50
$^{69}Zn^m$ (b)		2	50	0.5	10
^{69}Zn		4	100	0.5	10
^{88}Zr	Zirconium (40)	3	80	3	80
^{93}Zr		40	1000	0.2	5
^{95}Zr		1	20	0.9	20
^{97}Zr		0.3	8	0.3	8

[a] The curie values quoted are obtained by rounding down from the TBq figure after conversion to Ci. This ensures that the magnitude of A_1 or A_2 in Ci is always less than that in Tbq.

[b] A_l and/or A_2 value limited by daughter product decay.

[c] A_l and A_2 are unlimited for radiation control purposes only. For nuclear criticality safety this material is subject to the control placed on fissile material.

[d] These values do not apply to reprocessed uranium.

Alternatively, an A_2 value for mixtures may be determined as follows:

where is f (i) is the fraction of activity of nuclide i in the mixture and A_2 (i) is the appropriate A_2 value for nuclide i.

5. When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph 304. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters or beta/gamma emitters, respectively.

6. For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table II shall be used.

TABLE II. GENERAL VALUES FOR A_1 AND A_2

Contents	A_1	A_2

	TBq	(Ci)[a]	TBq	(Ci)[a]
Only beta or gamma emitting nuclides are known to be present	0.2	(5)	0.02	(0.5)
Alpha emitting nuclides are known to be present or no relevant data are available	0.1	(2)	2×10^{-5}	(5×10^{-4})

[a] The curie values quoted in parentheses are approximate values and are not higher than the TBq values

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Appendix H. Sample Safety and Health Plan for Service or Operations Contracts

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The offeror shall submit a detailed safety and health plan, as part of its proposal, showing how the contractor intends to protect the life, health, and well-being of NASA and contractor employees as well as property and equipment. The plan must include a detailed discussion of the policies, procedures, and techniques that will be used to ensure the safety and health of contractor employees and to ensure the safety of all working conditions throughout the performance of the contract. The plan must similarly address safety and health for subcontractor employees for any proposed subcontract whose value is expected to exceed $500,000 including commercial services and services provided in support of a commercial item. Also, when applicable, the plan must address the policies, procedures, and techniques that will be used to ensure the safety and health of NASA employees and the public. This plan, as approved by the contracting officer, will be included in any resulting contract. In addition, if a contractor is to work or be located on-site at a NASA facility or Center, the contractor will ensure the protection of personnel, property, equipment, and the environment in the production of contractor products and or the pursuit of any of its activities. In order for NASA to understand the contractor's method for compliance with pertinent NASA policies and requirements and Federal, State, and local regulations for safety, health, environmental protection, and fire protection, the contractor shall develop and subsequently implement a safety and health program in accordance with a safety and health plan generated by the contractor and approved by NASA. The plan will also assure the proper integration of the on-site contractor as a full participant in the Center's Safety and Health Program. This plan shall contain the information requested in the outline of contractor safety and health plan as follows:

Contents of the Contractor Safety and Health Plan

1.0 MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION.

1.1 Policy. Provide the contractor's corporate safety policy statement with the plan. Compare the contractor's policy statement with those of NASA and OSHA and discuss any differences.

1.2 Goals and Objectives. Describe specific goals and objectives to be met. Discuss status of safety program using the Performance Evaluation Profile (PEP) as safety performance criteria. Describe the contractor's approach (including milestone schedule) to achieve and maintain level 5 of the PEP in all areas (see contents of PEP).

1.3 Management Leadership. Describe management's procedures for implementing its commitment to safety and health through visible management activities and initiatives including a commitment to the exercise of management control to ensure workplace safety and health. Describe processes and procedures for making this visible in all contract and subcontract activities and products. Include a statement from the project manager or designated safety official indicating that the plan will be implemented as approved and that the project manager will take personal responsibility for its implementation.

1.4 Employee Involvement. Describe procedures to promote and implement employee (e.g., non-supervisory) involvement in safety and health program development, implementation, and decisionmaking. Describe the scope and breadth of employee participation to be achieved so that approximate safety and health risk areas of the contract are equitably represented.

1.5 Assignment of Responsibility. Describe line and staff responsibilities for safety and health program implementation. Identify any other personnel or organization that provides safety services or exercises any form of control or assurance in these areas. State the means of communication and interface concerning related issues used by line, staff, and others (such as documentation, concurrence requirements, committee structure, sharing of the work site with NASA and other contractors, or other special responsibilities and support). As a minimum, the contractor will identify the following:

a. Safety Representative. Identify by title the individual who will be responsible for the contractor's adherence to Center-wide safety, health, environmental, and fire protection concerns and goals, and who will participate in meetings and other activities related to the Center's Safety and Health program.

b. Company Physician. Provide the identification of a company physician to facilitate communication of medical data to the head of the NASA clinic. The contractor shall identify a point of contact (such as the company physician) by name, address, and telephone number to the NASA Center Clinic, mail code ____. Any changes that occur in the identity of the point of contact will be promptly conveyed to the NASA Clinic.

c. Building Fire Wardens. Each building occupied by the contractor shall assign an individual to facilitate the Center's fire safety program including coordination of related issues with NASA facility managers and emergency planning and response officials and their representatives.

d. Designated Safety Official. Identify by title the official(s) responsible for implementation of this plan and all formal contacts with regulatory agencies and with NASA.

1.6 Provision of Authority. Describe consistency of the plan with applicable NASA requirements and contractual direction as well as applicable Federal, State, and local regulations and how this will be maintained throughout the life of the contract.

1.7 Accountability. Describe procedures for ensuring that management and employees will be held accountable for implementing their tasks in a safe and healthful manner. The use of traditional and/or innovative personnel management methods (including discipline, motivational techniques, or any other technique that ensures accountability) will be referenced as a minimum and described as appropriate.

1.8 Program Evaluation. Describe the method for internal program evaluation. The program evaluation may consist of either (1) participation in a PEP survey at the request of the Government or (2) a written report which documents the contractor's procedures for determining the existence and criticality of the contractor's hazardous operations in a manner that proper risk management techniques can be applied and notable safety risk documented. The report will also include but is not limited to the following: identification of the contractor's hazardous operations and products; ranking the risk in a severity classification; approach to identifying and implementing specific risk evaluation tasks, managing the risks, and documenting the results; and responsibilities and methods for internal audits and evaluations of the overall safety and health program including personnel who conduct the audit and evaluation, to whom the report is made, and the frequency (at least annually) with which it is performed. These evaluations shall include subcontracted tasks. Correlation of the program evaluation to the applicable criteria of the PEP will be clearly described.

When a written program evaluation is requested, it will be delivered to the Government no later than 30 days after the end of each contract year or at the end of the contract, whichever is applicable. Distribution of these program evaluations will be the same as that for the safety and health plan. The PEP survey will be scheduled and administered at the discretion of the Government.

1.9 The contractor will describe its approach to document its safety and health program performance to provide the Government with the necessary visibility and insight. This includes the identification, acquisition, and processing of safety and health data; development of procedures; recordkeeping; statistical analyses including metrics; and the furnishing of data and reports to the Government. Electronic access by the Government to this data is preferred as long as Privacy Act requirements are met and Government safety and health professionals and their representatives have full and unimpeded access for review and audit purposes. For contractor activities conducted on NASA property, the contractor will identify what records it will make available to the Government in accordance with the Voluntary Protection Program criteria of OSHA as implemented in [local Center's] Requirements Handbook for Safety, Health, and Environmental Protection, as revised. For the purpose of this plan, safety and health documentation includes but is not limited to logs, records, minutes, procedures, checklists, statistics, reports, analyses, notes, or other written or electronic document which contains in whole or in part any subject matter pertinent to safety, health, environmental protection, or emergency preparedness. The contractor will acknowledge the following as standing requests of the Government to be handled as described below.

a. Roster of Terminated Employees. NASA will expect that terminated employees be reported to the Center occupational health program office. Identify personnel terminated by contractor. Send the report to the Occupational Health Officer no later than 30 days after the end of each contract year or at the end of the contract, whichever is applicable. At the contractor's discretion, the report may be submitted for personnel changes during the previous year or cumulated for all years.

Information required:

(1) Date of report, contractor identity, and contract number.

(2) For each person listed, provide name, social security number, assigned Center badge number, and date of termination.

(3) Name, address, and telephone number of contractor representative to be contacted for questions or other information.

b. Material Safety Data. Describe the procedure by which the contractor shall prepare and/or deliver to NASA, Material Safety Data for hazardous materials brought onto Government property or included in products delivered to the Government. These data are required by the Occupational Safety and Health Administration (OSHA) regulation, 29 CFR 1910.1200, "Hazard Communication," and Federal Standard 313 (or FED-STD-313), "Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities," as revised. A single copy of each Material Safety Data Sheet (MSDS) will be sent upon receipt of the material for use on NASA property to the Center's Central Repository, Mail Code ____, along with information on new or changed locations and/or quantities normally stored or used. If the MSDS arrives with the material and is needed for immediate use, the MSDS shall be delivered to the Central Repository by close of business of the next working day after it enters the site.

c. Hazardous Materials Inventory. The contractor shall compile an annual inventory report of all hazardous materials it has located on Government property and which is within the scope of 29 CFR 1910.1200, "Hazard Communication," and Federal Standard 313 (or FED-STD-313), "Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities," as revised. The call for this annual inventory is issued by the [responsible NASA official], mail code ____. This information shall provide the following:

(1) the identity of the material.

(2) the location of the material by building and room.

(3) the quantity of each material normally kept at each location.

1.10 Government Access to Safety and Health Program Documentation. The contractor shall recognize in its plan that it will be expected to make all safety and health documentation (including relevant personnel records) available for inspection or audit at the Government's request.

1.11 The contractor may be requested to participate in the review and modification of safety requirements that are to be implemented by the Government including any referenced documents therein. This review activity will be implemented at the direction of the NASA Contracting Officer's Technical Representative in accordance with established NASA directives and procedures.

1.12 Procurement. Identify procedures used to assure that the contractor's procurements are reviewed for safety considerations and that specifications contain appropriate safety criteria and instructions. Set forth authority and responsibility to assure that safety tasks are clearly stated in subcontracts.

2.0 WORKPLACE ANALYSIS. Describe the method by which hazards within the contractor's workplace shall be systematically identified during the duration of the contract. The identified method should explain the information collection process for assembling, through a combination of surveys, analyses, and inspections of the workplace, investigations of mishaps and close calls, and the collection and trend analysis of safety and health data such as: records of occupational injuries and illnesses; findings and observations from preventive maintenance activities; reports of spills and inadvertent releases to the environment; facilities related incidents related to partial or full loss of systems functions; employee reports of hazard; etc. Every hazard identified by any of the techniques identified below shall be ranked and processed in accordance with Center procedure. All hazards on NASA property, which are immediately dangerous to life or health, shall be reported immediately to the NASA safety office. All safety engineering products, which address operations, equipment, etc., on NASA property will be subject to the review and concurrence of the NASA Safety Office unless otherwise specified in the approved safety and health plan. The contractor is expected to have processes to address similar instances in contractor facilities utilizing contractor resources to manage such instances.

2.1 Hazard Identification. Describe the procedures and techniques to be used to compile an inventory of hazards associated with the work to be performed on this contract. This inventory of hazards shall address the work specified in this contract as well as operations and work environments which are performed in the vicinity or in close proximity to contract operations. The results will be reported to the Government in a manner suitable for inclusion in facilities baseline documentation as a permanent record of the facility. Specific techniques to be considered include:

a. Comprehensive Survey. A "wall to wall" engineering assessment of the work site including facilities, equipment, processes, and materials (including waste).

b. Change Analysis. Typically addresses modifications in facilities, equipment, processes, and materials (including waste); and related procedures for operations and maintenance. Change analyses periodically will be driven by new or modified regulatory and NASA requirements.

c. Hazard Analysis. May address facilities, systems/subsystems, operations, processes, materials (including waste), and specific tasks or jobs.

2.2 Inspections. This paragraph includes requirements for assignments, procedures, and frequency for regular inspection and evaluation of work areas for hazards and accountability for implementation of corrective measures. The contractor will describe administrative requirements and procedures for control of and regularly scheduled inspections for fire and explosion hazards. The contractor has the option, in lieu of this detail, to identify policies and procedures with the stipulation that the results (including findings) of inspections conducted on NASA property or involving Government furnished property will be documented in safety program evaluations or the monthly Accident/Incident Summary reports. Inspections will identify the following:

a. Discrepancies between observed conditions and current requirements.

b. New (not previously identified) or modified hazards.

2.3 Employee Reports of Hazards. Identification of methods to encourage employee reports of hazardous conditions (e.g., close calls) and analyze/abate hazards. The contractor will describe steps it will take to create reprisal-free employee reporting with emphasis on management support for employees and describe methods to be used to incorporate employee insights into hazard abatement and motivation/awareness activities.

3.0 MISHAP INVESTIGATION AND RECORD ANALYSIS.

3.1 Mishap Investigation. Identification of methods to assure the reporting and investigation of mishaps including corrective actions implemented to prevent recurrence. The contractor will describe the methods to be used to report and investigate mishaps on NASA property and on contractor or third party property. The contractor shall describe its procedures for implementing use of NASA mishap reporting and investigation forms and alternate forms used by the contractor with emphasis on timely notification of NASA; investigation procedures; exercise of jurisdiction over a mishap investigation involving NASA and other contractor personnel; follow up of corrective actions; communication of lessons learned to NASA; and solutions to minimize duplications in reporting and documentation including use of alternate forms, etc. The contractor will discuss its procedures for immediate notification requirements for fires, hazardous materials releases, and other emergencies. The contractor will include appropriate details to address the use of NASA Form 1627, "Mishap Report" (or equivalent), including 24-hour and ten-day mishap reports to the Occupational Safety Office, mail code ___. Note: the NASA Form 1627 is not attached since it is a three part carbonless form not conducive to reproduction. This form can be obtained from [source of supply].

3.2 Trend Analysis. Describe approach to performing trend analysis of data (occupational injuries and illnesses; facilities, systems, and equipment performance; maintenance findings; etc.) Discuss methods to identify and abate common causes indicated by trend analysis. In support of site-wide trend analysis to be performed by the Government, the contractor will discuss method of providing data as follows:

a. Accident/Incident Summary Report. The contractor shall describe how it shall prepare and deliver Accident/Incident Summary Reports as specified on [specify locally used format]. All new and open mishaps, including vehicle accidents, incidents, injuries, fires, and any close calls shall be described in summary form along with current status. Negative reports are to be required monthly. Report frequency is monthly; date due is the 10th day of the month following each month reported. Report to be delivered to the Center Safety Office, mail code _____.

b. Log of Occupational Injuries and Illnesses. For each establishment on and off NASA property that performs work on this contract, the contractor shall deliver to the Government (under separate contractor's cover letter), a copy of its annual summary of occupational injuries and illnesses (or equivalent) as described in Title 29, Code of Federal Regulations, Subpart 1904.5. If contractor is exempt by regulation from maintaining and publishing such logs, equivalent data in contractor's format is acceptable (such as loss runs from insurance carrier) which contains the data required. Data shall be compiled and reported by calendar year and provided to the Government within 45 days after the end of the year to be reported (e.g., not later than February 15 of the year following).

4.0 HAZARD PREVENTION AND CONTROL. Identified hazards must be eliminated or controlled. In the multiple employer environment of the Center, it is required that hazards including discrepancies and corrective actions be collected in the Center's information data system (provide name of system here) for risk management purposes. Describe your approach to implementing this requirement.

4.1 Appropriate Controls. Discuss approach to consideration and selection of controls. Discuss use of hazard reduction precedence sequence. Discuss approach to identifying and accepting any residual risk. Discuss implementation of controls including verifying effectiveness. Discuss scope of coverage (hazardous chemicals, equipment, discharges, waste, energies, etc.). Discuss need for coordination with safety, health, environmental services, and emergency authorities at NASA.

4.1.1 Hazardous Operations. Establish methods for notification of personnel when hazardous operations are to be performed in their facilities or when hazardous conditions are found to exist during the course of this contract. NASA policy will serve as a guide for defining, classifying, and prioritizing hazardous operations. Develop and maintain a list of hazardous operations to be performed during the life of this contract. The list of hazardous operations will be provided to the contracting officer as part of the safety plan for review and approval. The contracting officer (CO) and the contractor will decide jointly which operations are to be considered hazardous, with the CO as the final authority. Before hazardous operations commence, the contractor will develop a schedule to develop written hazardous operations procedures with particular emphasis on identifying the job safety steps required. The contractor may implement this requirement as follows:

a. Identify contractor policies and procedures for management and implementation of hazardous operations procedures together with a statement that NASA will have access on request to any contractor data necessary to verify implementation; or

b. In lieu of contractor management and development of such procedures, identify the method whereby the contractor will identify and submit such procedures to the NASA Occupational Safety Office for review and approval.

4.1.2 Written Procedures. Identification of methods to assure that the relevant hazardous situations and proper controls are identified in documentation such as inspection procedures, test procedures, etc., and other related information. Describe methods to assure that written procedures are developed for all hazardous operations, including testing, maintenance, repairs, and handling of hazardous materials and hazardous waste. Procedures will be developed in a format suitable for use as safety documentation (such as a safety manual) and be readily available to personnel as required to correctly perform their duties.

4.1.3 Protective Equipment. Set forth procedures for obtaining, inspecting, and maintaining protective equipment, as required, or reference written procedure pertaining to this subject. Set forth methods for keeping records of such inspections and maintenance programs.

4.1.4 Hazardous Operations Permits. Identify facilities, operations, and/or tasks where hazardous operations permits will be required as specified in the Center's local requirement. Set forth guidance to adhere to established NASA Center procedures. Clearly state the role of the safety group or function to control such permits.

a. Operations Involving Potential Asbestos Exposures. Set forth method by which compliance is assured with the Center's Asbestos Control Program as established in local policy.

b. Operations Involving Exposures to Toxic or Unhealthful Materials. Such operations must be evaluated by the NASA Occupational Health Office and must be properly controlled as advised by same. The NASA Occupational Health Office must be notified prior to initiation of any new or modified operation potentially hazardous to health.

c. Operations Involving Hazardous Waste. Identify procedures used to manage hazardous waste from point of generation through disposal. Clearly identify divisions of responsibility between contractor and NASA for hazardous waste generated throughout the life of the contract. Operations which occur on site must also be evaluated by the Center environmental services office and must be properly controlled as advised by same. The Center environmental services office must be notified prior to initiation of any new or modified hazardous waste operation on site.

d. Operations Involving New or Modified Emissions/Discharges to the Environment. Set forth methods for identifying new or modified emissions/discharges and coordinating results with the Center environmental services office. Set forth procedures to minimize or eliminate environmental pollution. Address management of hazardous materials; substitution of non-hazardous or less hazardous materials for hazardous materials; proper segregation of hazardous wastes from non-hazardous wastes; and other methods described by NASA. Emphasis shall be placed on providing for sufficient lead-time for processing permits through the appropriate State agency and/or the Environmental Protection Agency.

4.2 Discuss your responsibilities for maintaining facilities baseline documentation in accordance with Center requirements. The contractor will implement any facilities baseline documentation tasks (including safety engineering) as provided in the contractor's safety and health plan approved by NASA or as required by Government direction.

4.3 Preventive Maintenance. Discuss approach to preventive maintenance. Describe scope, frequency, and supporting rationale for your preventive maintenance program including facilities and/or equipment to be emphasized or de-emphasized. Discuss methods to promote awareness in the NASA community (such as alerts, safety flashes, etc.) when preventive maintenance reveals design or operational concerns in facilities and equipment (and related processes where applicable).

4.4 Medical Program. Discuss your medical surveillance program to evaluate personnel and workplace conditions to identify specific health issues and prevent degradation of personnel health as a result of occupational exposures. Discuss approach to cardiopulmonary resuscitation (CPR), first aid, and emergency response.

5.0 EMERGENCY RESPONSE. Discuss approach to emergency preparedness and contingency planning which addresses fire, explosion, inclement weather, environmental releases, etc. Discuss compliance with 29 CFR 1910.120 (HAZWOPER) and the role the contractor will play in the local Incident Command System. Discuss methods to be used for notification of Center emergency forces including emergency dispatcher, safety hotline, director's safety hotline, etc. Discuss establishment of pre-planning strategies through procedures, training, drills, etc. Discuss methods to verify emergency readiness.

6.0 SAFETY AND HEALTH TRAINING. Describe the contractor's training program including identification of responsibility for training employees to assure understanding of safe work practices, hazard recognition, and appropriate responses including protective and/or emergency countermeasures. Address management techniques used to identify and utilize any Center training resources (such as asbestos worker training/certification, hazard communication, confined space entry, lockout/tagout, etc.) as appropriate with particular emphasis on programs designed for the multiple employer work environment on NASA property. Describe approach to training personnel in the proper use and care of protective equipment. Discuss tailoring of training towards specific audiences (management, supervisors, and employees) and topics (safety orientation for new hires, specific training for certain tasks or operations). Discuss approach to ensure that training is retained and practiced. Discuss personnel certification programs. Certifications should include documentation that training requirements have been satisfied and learning validated by one or more of the following: physical examination, testing, on-the-job performance, etc. All training materials and training records will be provided for NASA review on request.

Appendix I. Sample System Safety Plan for Systems Acquisition, Research, and Development Programs

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The NASA program manager (or designee) will publish and maintain an approved System Safety Plan (SSP), appropriate to and for the life of the program. This plan may be incorporated in the more comprehensive safety and mission assurance plan, mission assurance plan, etc., providing the required data are identifiable and complete.

1. The SSP defines the objectives, responsibilities, and methods to be used for overall safety program conduct and control. Integration of system/facility safety provisions into the SSP is vital to the early implementation and ultimate success of the safety effort. Inclusion of these provisions in the plan will send an unmistakable message to all program participants that safety is an integral part of the management process and all tasks. The authority to conduct the safety program must originate in the respective SSP governing each NASA program.

2. The program SSP shall be the vehicle for safety task planning. The plan will include detailed task requirements for the system safety task as tailored from this document for the program. The NASA program organization and system safety relationships and responsibilities will be described along with reporting channels for this task. In particular, the plan will show how NASA safety will manage its independent oversight role. The plan will stipulate hazard analysis methodologies, hazard report (HR) data and format requirements, and the approval reporting channels for HR's and their milestones. It will address requirements for NASA and contractor participation in design, safety, and readiness reviews. The program SSP shall be a compliance document in the request for proposal (RFP). Data requirements for the program SSP are in the data requirements document. For a multi-Field Installation program, each Field Installation should supplement the plan to ensure its compatibility with the Field Installation organization and ability to comply with task requirements.

3. The level of safety directly correlates with management's emphasis on the safety of the system/facility being developed. Proper identification of the system/facility safety program elements is the first step towards developing a successful program. Each functional safety program has the following 10 basic elements:

a. Planning

b. Organization.

c. Contracting.

d. Interface/Coordination.

e. Requirement.

f. Analysis.

g. Risk assessment.

h. Reporting.

i. Mishap investigation.

j. Data retention.

4. Each of these elements is aligned with an overall approach to risk evaluation by:

a. Identifying system/facility safety hazards.

b. Determining corrective actions to either eliminate or control the safety hazard.

c. Recommending corrective action or alternatives to the appropriate management level for a decision to either eliminate the hazard or accept the risk. Residual risk acceptance may be handled at varied levels. The higher risks must be accepted by the program manager. In all cases, notification of that risk acceptance will be communicated to the next higher authority (see Chapter 3).

d. Documenting those areas in which a decision has been made to accept the risk, including the rationale for the risk acceptance.

5. During the concept phase, appropriate safety tasks should be planned that will become the foundation for safety efforts during the system definition, design, manufacture, test, and operations.

a. Identify special safety studies that may be required during system definition or design.

b. Estimate gross milestone personnel requirements for the safety program during the complete system life cycle.

c. Perform trade studies by using the result of the preliminary hazard analysis that identified highly hazardous areas, with recommended alternatives.

d. Establish safety goals and objectives to determine the type of safety input for the overall program.

(1) Goals should be measurable and state what would be accomplished by performing the various safety tasks.

(2) Goals should be structured so that safety tasks can be selected to accomplish them.

(3) Task results should clearly demonstrate that the goals have been met.

e. Complete preliminary hazard analyses to identify potentially hazardous systems and to develop initial safety
requirements and criteria.

f. Review the gross hardware requirements and concepts to maintain an understanding of the evolving system.

g. Review pertinent historical safety data from similar systems.